

















# Journal of the New York Entomological Society



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# Journal

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## JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY

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## A NEW SPECIES OF *MICROMUS* FROM THE WESTERN UNITED STATES (NEUROPTERA: HEMEROBIIDAE)

JOHN D. OSWALD

Department of Entomology, Cornell University,  
Ithaca, New York 14853

**Abstract.**—The hemerobiid, *Micromus remiformis* is described as new from western North America. Illustrations of the male genitalic structures of *M. remiformis* and the closely related Nearctic *M. montanus* are presented.

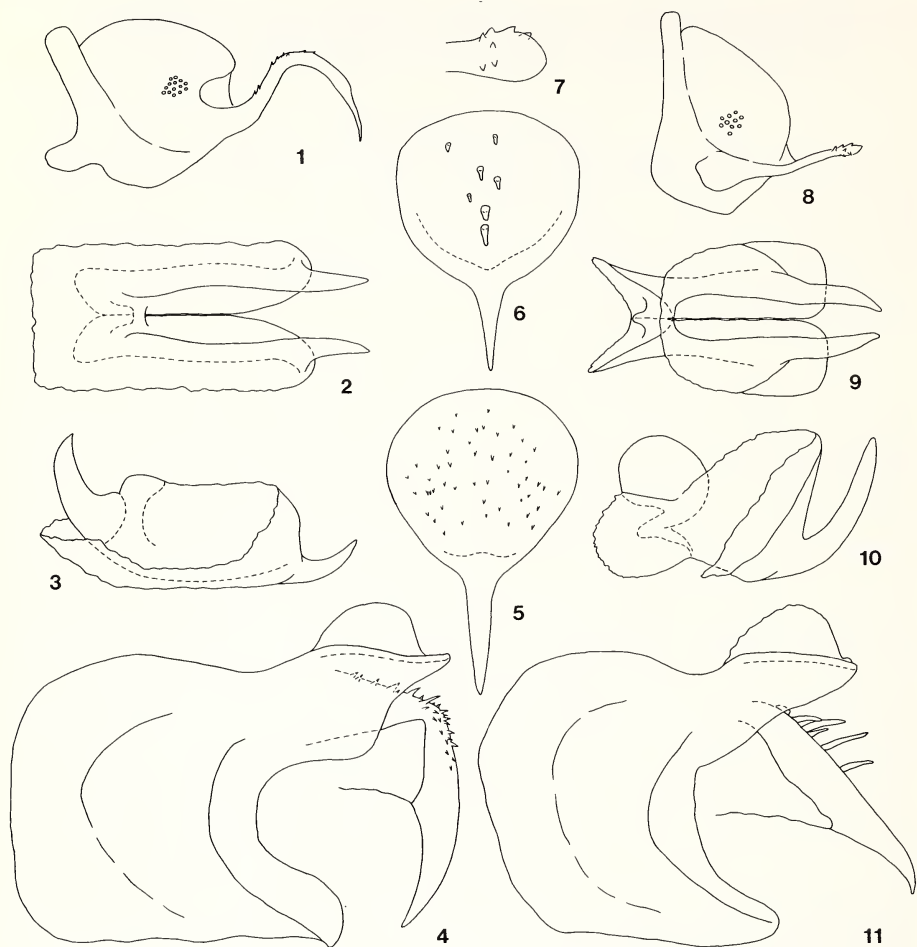
Carpenter (1940) diagnosed and provided a key to the five species of the genus *Micromus* then known from America north of Mexico: *M. angulatus* (Stephens), *M. posticus* (Walker), *M. subanticus* (Walker), *M. variolosus* Hagen and *M. montanus* Hagen. A recent reexamination of North American *Micromus* species has revealed an additional undescribed species closely related to, and previously included in the concept of *M. montanus*.

Since the disparate views of Tjeder (1961), who listed 18 generic synonyms of *Micromus*, and Nakahara (1960), who recognized 11 of these synonyms as valid genera, there has been a trend, primarily by European workers (e.g., Zeleny, 1963; Aspöck et al., 1980), toward recognizing several subgenera within *Micromus* s.l. (e.g., *Nesomicromus*, *Pseudomicromus*, *Stenomicromus*). Though it seems useful to identify species groups within *Micromus* in regional faunas as an initial approximation of intrageneric relationships, a cosmopolitan revision of *Micromus* adequately delimiting such groups between regional faunas is presently lacking. Consequently, I believe it is premature to assign subgeneric status to these groups and *M. remiformis*, n. sp. is thus proposed without subgeneric assignment. However, the shape and dorsal spination of the mediuncus, the presence of a dorsal longitudinal keel on the gonarcus bridge and the dorsally lobed condition of the two acute paramere processes strongly suggest a close relationship with the Nearctic *M. montanus* and the European *M. paganus* (Linnaeus), *M. gradatus* Navas and *M. lanosus* (Zeleny).

### ***Micromus remiformis*, new species**

Figs. 6-11

**Description.** Size: Forewing length: 8.8-10.7 mm ( $\bar{x}$  = 10.0, N = 9); forewing width: 3.5-4.4 mm ( $\bar{x}$  = 4.1, N = 9). Coloration: Wing membrane hyaline to pale yellow with light brown mottling. Inner and outer gradate series banded with light brown, veins predominantly yellowish. Head, body and legs yellow-brown. Venation: Number of oblique radial branches: 4 (22% of wings examined), 5 (72%), 6 (6%). Number of inner gradate crossveins distal to cubitus: 5 (33%), 6 (61%), 7 (6%). Number of outer gradate crossveins distal to cubitus: 8 (17%), 9 (61%), 10 (22%). MP3+4 fused to Cu1a for a short distance or joined by a short crossvein; first fork of Cu1a beyond its connection with MP3+4 (by fusion or crossvein) closer to that connection than



Figs. 1-11. *M. montanus*. 1. Ninth tergite and ectoproct, lateral. 2. Parameres, ventral. 3. Parameres, lateral. 4. Gonarcus and mediuncus, lateral. 5. Mediuncus, dorsal surface; *M. remiformis*, n. sp. 6. Mediuncus, dorsal surface. 7. Apex of ectoproct process, dorsal. 8. Ninth tergite and ectoproct, lateral. 9. Parameres, ventral. 10. Parameres, lateral. 11. Gonarcus and mediuncus, lateral. Figures shown to same scale: 1 = 8, 2 = 3 = 4 = 5 = 6 = 7 = 9 = 10 = 11.

to wing margin. Male genitalia (Figs. 6-11): Ninth tergite (Fig. 8): slightly broadened anterolaterally but without a distinct anteriorly directed lobe. Ectoproct (Figs. 7, 8): ventral process weakly sinuate, its apex flattened, slightly clubbed and bearing several small teeth. Gonarcus (Fig. 11): bridge with dorsal, longitudinal keel. Mediuncus (Figs. 6, 11): proximal plate broad, its surface usually with fewer than 10, mostly elongate, teeth; apical attenuation short and slender. Parameres (Figs. 9, 10): posterior pair of processes long, strongly reflexed; anterior region of parameres fused into a



compressed plate dorsally and a pair of plates ventrolaterally; ventrolateral plates enclose a median ventral knob. This description is based on 9 males forming the type series. Female genitalia: Subgenitale small, emarginate posteriorly. A pair of large, ventrally convergent, sclerotized plates present dorsal to the subgenitale.

**Diagnosis.** *M. remiformis* is indistinguishable from *M. montanus* based on external coloration and venation. *Micromus remiformis* males are readily differentiated from those of *M. montanus* by the weakly sinuate, clubbed ectoproct process which is usually visible without dissection. Males of *M. remiformis* may be further distinguished by the unlobed anterolateral margin of the ninth tergite, the relatively small number and elongate nature of the mediuncus teeth, and the long reflexed processes of the parameres. *Micromus montanus* possesses the following corresponding characters: anterolateral margin of ninth tergite prominently lobed (Fig. 1); mediuncus teeth short and numerous (Figs. 4, 5); apical processes of parameres short and weakly reflexed (Figs. 2, 3).

Females of *M. remiformis* and *M. montanus* are very similar. The sclerotized plates dorsal to the subgenitale in *M. remiformis* also occur in *M. montanus* but are typically smaller and only weakly convergent ventrally. The reliability of this character for species diagnosis needs corroboration, particularly in areas of parapatry where intermediate character states could occur.

**Etymology.** From the Latin "remus," oar and "forma," shape, in reference to shape of male ectoproct process.

**Distribution.** *M. remiformis* is a montane species distributed throughout the western United States, east to northeastern Idaho and central Utah, and south to at least San Bernardino County, California. The distribution of the closely related *M. montanus* is boreal, extending south in the Appalachian and Rocky mountains at higher elevations. Although the distribution of these species in the western Cordillera is not well known, present records suggest that *M. montanus* and *M. remiformis* are allopatric.

**Holotype.** ♂, in the collection of the California Academy of Sciences. Label data: "CALIF. Madera Co., / Big creek at Boggy / Meadow 4.75 air mi / ESE. of Fish Camp. / Alt. 6400 ft. Aug. / 9, 1971 H. B. Leech," "Holotype / *Micromus remiformis* Oswald / J. D. Oswald 1985." Condition: Excellent, genitalia in glycerin-filled microvial pinned below specimen.

**Paratypes.** 8♂♂ as follows: U.S.A.: **California:** *Mono Co.:* 1 mi W Tom's Place, VIII-13-1957 (UCB), 4 mi E Monitor Pass, VII-15-1966 (author's collection). *Placer Co.:* Ward Cr., 2 mi S Tahoe City, VIII-24-1966 (LACM). *Siskiyou Co.:* Mt. Shasta, McBride Spr., 5,000', VII-21-1966 (UCB). **Idaho:** *Shoshone Co.:* 2♂♂, Wallace, V-17 & VII-17-1938 (author's collection, UMSP). **Nevada:** *Elko Co.:* Thomas Cyn. Camp, 9 mi SSE Lamoille [sic = Lamoille], 7,500', VII-4-1966 (AMNH). *White Pine Co.:* Lehman Cr., 11 km W Baker, 7,500', VII-25-1981 (author's collection).

**Other material.** 32♀♀ as follows: U.S.A.: **California:** *Inyo Co.:* Sage Flat Camp, 10 mi W Big Pine, VII-20-1964 (CAS). *Plumas Co.:* 4 mi W Quincy, VI-24-1949 (UCD); 2♀♀, Johnsville, IX-27-1963 (UCD). *San Bernardino Co.:* Camp O'Ongo, nr. Running Sprgs., VIII-25-1981, 6,200' (LACM). *Shasta Co.:* Hat Creek P.O., VII-16-1955 (LACM). *Siskiyou Co.:* 2♀♀, Mt. Shasta, McBride Spr., VII-21-1966 (UCB). *Tuolumne Co.:* 3♀♀, Twain Harte, IX-1/28, 4,000' (author's collection, UCB, CAS). **Idaho:** *Latah*

*Co.*: Moscow Mt., [no date] (WSU). *Shoshone Co.*: 17♀♀, Wallace, V-17/VII-29, 3,000' (author's collection, CMP, UMSP). **Oregon**: *Curry Co.*: Harbor, VI-10-1963, beach at high tidemark (OSU). *Jefferson Co.*: 2 mi SE Suttle Lk., VIII-13-1983 (author's collection). **Utah**: *Utah Co.*: 10 mi E Alpine, VIII-8-1953 (UCD).

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**EREMOCHILINI, A NEW TRIBE OF NEOTROPICAL  
EPILACHNINAE (COLEOPTERA: COCCINELLIDAE)**

ROBERT D. GORDON AND NATALIA VANDENBERG

Systematic Entomology Laboratory, BBII, Agricultural Research Service, USDA,  
% U.S. National Museum of Natural History, Washington, D.C. 20560 and  
2634 Virginia Street #31, Berkeley, California 94709

*Abstract.*—A new tribe, Eremochilini (Epilachninae), is erected to contain the genus *Eremochilus* Weise which was previously misclassified in the subfamily Coccidulinae. Two species are recognized in *Eremochilus*; *E. peregrinus* Weise, and *E. weisei*, new species.

An examination of the unique female holotype of *Eremochilus peregrinus* Weise revealed that it belongs in the subfamily Epilachninae rather than in the Coccidulinae where it has resided since the original description. We find that a new tribe of Epilachninae, Eremochilini, is needed to contain *Eremochilus* and that the subfamily description must be altered slightly. The new tribe is integrated into the existing classification (Gordon, 1976) and a new key to the tribes of Epilachninae constructed.

Four specimens in the collections of the National Museum of Natural History, Washington, D.C. (USNM), the Universidad Federal do Parana, Curitiba, Brasil (UFPC), and William H. Nutting (WHN), represent an unnamed species of *Eremochilus* which we describe here.

We are indebted to Manfred Uhlig, Zoological Museum, Humboldt University, Berlin, for the loan of the type specimen of *Eremochilus peregrinus*, and to R. Pope, British Museum (Natural History), London; J. Chapin, Louisiana State University, Baton Rouge; and E. Baker and R. Smiley, Systematic Entomology Laboratory, USDA, Beltsville, Maryland, for reviewing the manuscript.

Epilachninae

Epilachniens Mulsant, 1846:190.  
Epilachninae Ganglbauer, 1899:947; Gordon, 1976:16.

The following changes are made to the subfamily description by Gordon (1976: 16) in order to accommodate the Eremochilini:

Occiput of head normal or *expanded partially to partially shield base of mandible*. Labrum present or *absent*. Labium with palpal insertion median, subterminal, or *terminal*. Antenna 10- or 11-segmented, inserted in depression on inner side of eye, depression sometimes *partially enclosing antennal base*. Mesosternum with or *without* triangular notch medially on anterior margin for reception of prosternal process.

KEY TO TRIBES OF EPILACHNINAE

- 1. Labrum absent; base of mandible with large, hairy pad (Fig. 1) . . Eremochilini, new tribe
- Labrum present; base of mandible without hairy pad . . . . . 2

2. Apex of tibia with at least one apical spur; leg slender, tarsus received in tibial groove; epipleuron descending externally or not, never with depression for apex of femur; form variable ..... *Epilachnini*
- Apex of tibia with or without spurs; anterior tibia short, wide; middle and hind tibiae with tarsus not received in tibial grooves, epipleuron always descending externally, nearly always with distinct depression for reception of femur; small; form round, convex ..... *Madaini*

### **Eremochilini, new tribe**

Epilachninae with body elongate oval, somewhat oblong. Head with occiput below eye expanded forward, partially enclosing mandible base. Labrum absent; mouthparts directed posteriorly; mandible long, base with hairy pad (Fig. 1). Antenna 10-segmented, club short, compact, 3-segmented. Pronotum short, transverse. Mesosternum truncate apically, lacking notch for reception of prosternal process. Leg slender, tibia as long as femur, lacking apical spurs; tarsus received in shallow tibial groove; tarsal claw with subquadrate basal tooth. Postcoxal line complete, recurved to base of 1st abdominal sternum.

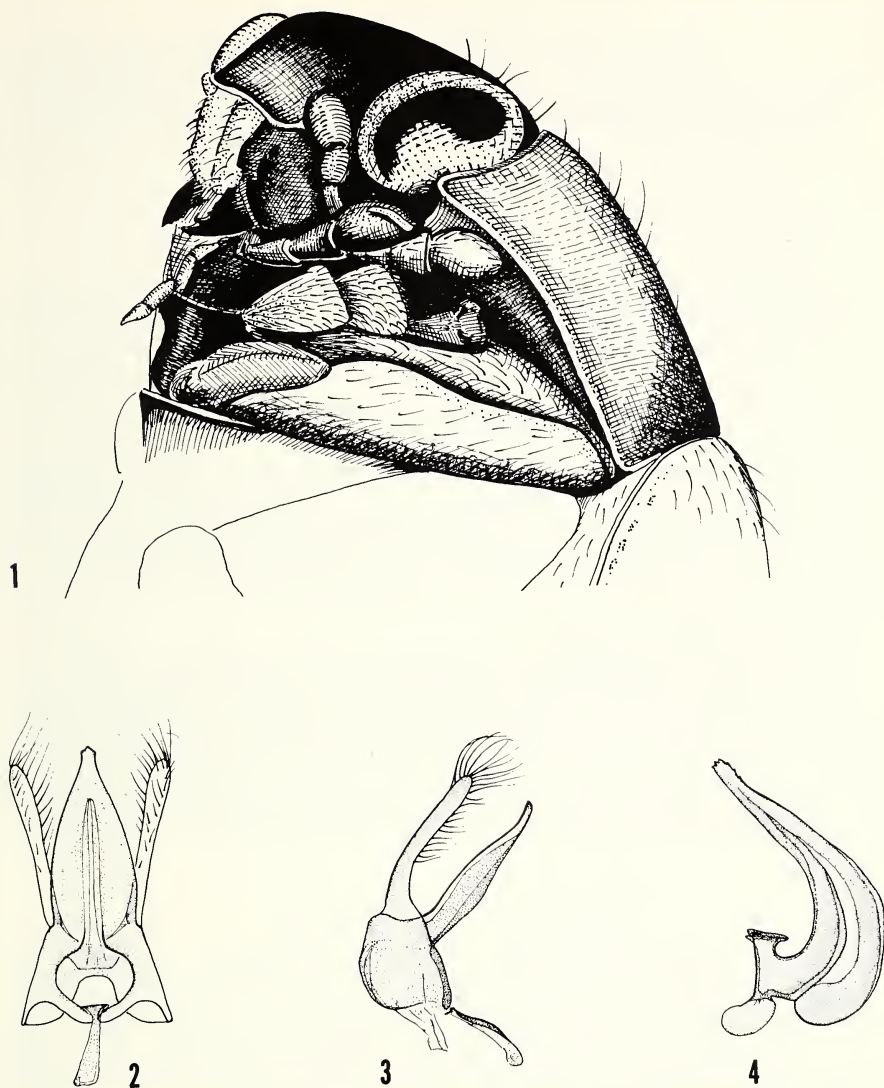
The tribe currently contains only the genus *Eremochilus*. This genus is so aberrant in structure that Weise originally placed it near *Rhyzobius* in the subfamily Coccidulinae. The characters that are unusual in the Epilachninae are: occiput of head below eye produced forward, partially shielding base of mandible; absence of a labrum; mouthparts, including the mandible, extremely elongated and directed posteriorly between the front coxae; presence of a large, hairy pad at the mandible base; and 10-segmented antenna. However, the head shape, antennal placement, and multidentate mandibles are unmistakably epilachnine, and we transfer the genus accordingly.

The Eremochilini appear to derive from the Epilachnini, suggesting that the latter group is paraphyletic. This topic is left for future discussion, as it requires a reassessment of the groups and group characters within certain Epilachnini (notably, the *cacica* group of *Epilachna* and the genus *Dira* as defined by Gordon, 1976).

### *Eremochilus* Weise

Eremochilini with elongate body, sides nearly parallel, dorsal and ventral pubescence short, sparse. Clypeus very short anterior to antennal insertion; apex of mandible with 3 teeth (Fig. 1); labial palpus inserted posterior to apex of mandible, immediately above prosternum. Epipleuron nearly flat, without depressions for reception of femoral apices. Postcoxal line on 1st abdominal sternum not extending beyond middle of sternum. Apical abdominal sternum notched in male. Male genitalia with short, broad siphon (Fig. 4).

Host plant data are completely lacking for the members of this genus, which is most unfortunate. We consider *Eremochilus* to be a highly derived member of the Epilachninae rather than a primitive form, and knowledge of the host plant(s) might shed light on the reasons for the bizarre structural modifications of the mouthparts and unusual body form.



Figs. 1-4. *Eremochilus weisei*. 1. Lateral view of head and pro- and mesosternum. 2-4. Male genitalia. 2. Ventral view of phallobase. 3. Lateral view of phallobase. 4. Lateral view of siphus.



KEY TO SPECIES OF *EREMOCHILUS*

1. Clypeal apex emarginate; abdominal sterna 2–4 smooth, lacking transverse rugae; Bolivia ..... *peregrinus* Weise
- Clypeal apex truncate; abdominal sterna 2–4 noticeably punctate, with transverse rugae in basal 1/3; Brasil ..... *weisei*, n. sp.

*Eremochilus peregrinus* Weise

*Eremochilus peregrinus* Weise, 1912:118; Korschefsky, 1931:81.

*Description.* Female, length 3.60 mm, width 2.20 mm, widest at middle of elytra. Color yellowish brown except elytron bluish black, apical 1/3 of mandible dark reddish brown. Head smooth, punctures separated by less than a diameter. Pronotum not examined. Elytron with surface smooth, punctures coarser than on head, separated by a diameter or less. Mesosternum polished, with fine, widely separated punctures. First abdominal sternum smooth except median area alutaceous with sparse punctures; postcoxal line extending to middle of sternum. Sterna 2–4 smooth with scattered punctures. Fifth sternum alutaceous, densely punctured, apex rounded. Sixth sternum and tergum entire, not apically emarginate. Genitalia with 10th tergum apically truncate; genital plate transverse with broadly rounded apex, stylus not visible.

*Male.* Not known.

*Type locality.* Bolivia, Mapiri.

*Type depository.* Zoological Museum, Humboldt University, Berlin, DDR.

*Remarks.* The unique female holotype was the only specimen of this species available for study. It was badly damaged in shipment and the pieces are now glued to a card mount. All parts were retrieved except the pronotum and legs so it was possible to examine the most important structures. The holotype is labeled "Bolivia Mapiri (green paper)/Mapiri Bolivia/Typus (red paper)/*Eremochilus peregrinus* m/Zool. Mus. Berlin."

*Eremochilus weisei*, new species

*Description.* Male, length 3.60 mm, width 2.20 mm, widest at middle of elytra. Color yellowish brown except head and mesosternum dark brown, apical 1/3 of mandible dark reddish brown; pubescence yellowish white. Head smooth, polished, punctures separated by 1 or 2 times a diameter. Pronotum with lateral border finely margined, slightly explanate, surface polished, punctures separated by one to 3 times a diameter. Elytron with surface slightly alutaceous, punctures larger than on pronotum, separated by a diameter or less. Mesosternum polished with fine, widely scattered punctures. First abdominal sternum smooth with coarse punctures medially, separated by less than a diameter; postcoxal line not quite reaching middle of sternum. Sterna 2–5 with transverse rugae on basal 1/3, punctures becoming progressively coarser and denser from 2nd through 5th sterna; apex of 5th sternum notched. Genitalia with basal lobe longer than paramere, tapered to triangular apex; paramere slender (Figs. 2, 3); siphon with denticles at apex and on dorsal margin just before apex (Fig. 4).

*Female.* Similar to male except 5th abdominal sternum triangularly produced

medially; 6th sternum and tergum entire. Genitalia with 10th tergum convex; genital plate with lateral margin angled to rounded apex, stylus not visible.

*Variation.* Length 3.40 to 4.0 mm, width 2.0 to 2.30 mm. One paratype differs strongly in color pattern: head reddish brown with black vertex, and elytron, pro-, meso-, and metasterna, and median area of abdominal sterna 1–4 black.

*Type material.* Holotype, Brasil, Estado de Sao Paulo, Aug 31, 1919, EG Holt Collector (USNM). Three paratypes with the following data: Brasil, Nova Teutonia, SC, V-1966, XII-1966, F. Plaumann col; Brasilien, Nova Teutonia, 27 11' B 52 23' L, Fritz Plaumann (UFPC; USNM; WHN).

*Remarks.* In addition to the key characters, *E. weisei* differs from *E. peregrinus* in having the head less densely punctured, and the elytra yellowish brown or black rather than bluish black. The female genital plates are completely different in shape between the 2 species.

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***CARABUS AURATUS* L. AND *CLIVINA FOSSOR* L.  
(COLEOPTERA: CARABIDAE): NEW RECORDS OF TWO  
INTRODUCED TAXA IN THE NORTHWEST  
AND NORTHEAST U.S.A.**

ROBERT E. NELSON<sup>1</sup> AND ROSS A. REYNOLDS<sup>2</sup>

<sup>1</sup>Department of Geology and <sup>2</sup>Department of Physics, Colby College,  
Waterville, Maine 04901-4799

*Abstract.*—*Carabus auratus* L. and *Clivina fossor* L. are newly recorded from Maine. The Pacific Coast distribution for *C. fossor* is extended to southern Oregon.

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The documentation of the spread of introduced taxa into exotic environments, and changes in their known ecological preferences in these new habitats, is often not completed until a major taxonomic revision or study of the fauna of a particular region is undertaken. Much of what is known of the distribution of many organisms is passed by word of mouth among professionals with access to major museum collections, and often does not appear in the published literature for decades. This kind of information, however, is critical to those who use fossil remains in geological contexts as indices of environmental change. Important questions to such studies include: how rapidly can a given group of organisms disperse into a new environment and thereby reflect changing environmental conditions? How variable are the habitats in which a given organism can survive?

Numerous taxa, both plant and animal, have been introduced into North America since the advent of European colonization. (For instance, Hatch [1953] lists over 165 beetle taxa known to be introduced to the Pacific Northwest prior to 1952.) This report documents several new localities in the U.S. for two introduced Carabid beetle species, *Carabus auratus* L. and *Clivina fossor* L., both of which are apparently well established on this continent and presently expanding their respective ranges.

The applicability of documenting the spread of these and other introduced taxa to the paleobiogeographic questions posed above presupposes that the artificial range extensions involved reflect uninhibited expansion without significant competition, as would be the case, for instance, with insects expanding into recently deglaciated terrain. In the case of the flightless *Carabus auratus*, this range extension after initial introduction has likely been almost entirely accomplished by walking of both larval and adult individuals, occasionally augmented by human transportation in farm products, etc. Its spread northwards in New England is likely limited by the lack of suitable habitat; natural environments in this region are dominated overwhelmingly by hardwood and conifer forests. The only other species of *Carabus* taken in association with *C. auratus* is *C. nemoralis* Muller, also a European introduction into North America, although several individuals of the native species *C. serratus* have been collected in this same region (Nelson, unpubl. data).

In the case of *Clivina fossor*, the power of flight vastly improves the chances of individual beetles to disperse in search of new suitable habitats, and it should be



expected that this species would exhibit rapid range expansion once established. Palmén (1944; cited in Thiele, 1977) found it one of the more abundant Carabid species washed ashore along the southwest coast of Finland, evidence that this species does indeed utilize flight as a means for dispersal into new habitats. It is highly likely that its present range on both the east and west coasts of the U.S. extends considerably beyond that documented here. It is unlikely as well that this species faces significant competition from native species, particularly in disturbed agricultural areas, considering its southwards range expansion on the Pacific Coast by at least 20 km/yr since 1953. On the Atlantic Coast, it could very well have been in Maine for decades and remained undetected, inasmuch as this region has not been extensively collected and vast areas remain relatively unstudied.

*CARABUS AURATUS* LINNAEUS

Eighteen specimens of this distinctive, metallic green species have been recovered recently in the central Maine area, and numerous others have been observed but not collected. The species is apparently well established there. Lindroth (1961, p. 37) noted only that it was "a late introduction and established only in the coastal districts of New England." The localities reported here are some 40–50 miles inland from the coast and may well represent both inland and northwards expansion of the range from that previously recognized. The Smithfield specimen documented below was collected in an open stable yard, whereas the specimens from Sidney, Maine, were collected in a densely vegetated hayfield which has been mowed twice annually for decades. This site has recently been disturbed for construction of a home. Thiele (1977) noted that in Europe, the species is more common on cropland than in meadows or pastures, but it has not been observed in Maine in cultivated fields. Both the Smithfield and Sidney sites are in rural areas where it is more likely that this flightless species has become naturally established rather than artificially introduced from a distant population in southern New England.

Decimal coordinates for the more recent specimens listed below (for both species) follow Crawford (1983) as a means of precisely locating sites with a minimal number of characters.

*Localities. MAINE:* Somerset Co./ Smithfield: 44°46'N, 69°25'W/ VI-1984/ C. W. Ridky, coll. (1 specimen); Kennebec Co./ Sidney: 44.489°N, 69.689°W/ 11-VI-1985/ R. A. Reynolds, coll. (1 specimen); Kennebec Co./ Sidney: 44.489°N, 69.689°W/ 14-VI-1985/ R. E. Nelson, coll. (1 specimen); Kennebec Co./ Sidney: 44.489°N, 69.689°W/ 10-V-1986/ R. E. Nelson & R. A. Reynolds, coll. (6 specimens: 1 male, 5 females); Kennebec Co./ Sidney: 44.489°N, 69.689°W/ 18-V-1986/ R. E. Nelson & R. A. Reynolds, coll. (9 specimens: 6 males, 3 females).

*CLIVINA FOSSOR* LINNAEUS

According to Lindroth (1961, p. 161), this species was introduced into eastern Canada in 1915, and in the U.S.A. is known from just Washington State. Lindroth only recorded the species from the eastern half of Canada, although Finlayson and Campbell (1976) have since noted populations estimated at as many as 11,000 individuals per hectare in the lower Fraser River valley of southwestern British

Columbia. As regards the U.S. records, Lindroth cited Hatch (1953), who stated that the species was found in "western Washington, Seattle and vicinity" (Hatch, 1953, p. 66).

Ecologically, Lindroth (1961) indicated that *C. fossor* was found "in North America on cultivated, usually clayish soil" (Lindroth, 1961, p. 161). Larochelle (1976), however, has recently reported collecting the species by treading in an undisturbed marshy embayment in Quebec. Thiele (1977) notes that in Europe it is a species of moist meadows and agricultural land, including pastures.

The new records presented in this report indicate that: (a) on the Pacific Coast, *C. fossor* has expanded its range in Washington State to east of the Cascade Range, as well as southwards at least into southernmost Oregon; (b) the species has extended its range southwards along the Atlantic Coast at least as far as central Maine; and (c) the environments in which it is found on both coasts of the U.S. now include a wide variety of undisturbed natural habitats.

The specimens reported here have been collected in a boggy pasture with abundant organics and a clay-rich substrate (Edmonds, Washington); in a relatively dry pasture with a silty sand substrate (Kittitas Co., Washington); at the margin of cultivated fields (Somerset Co., Maine); in a moist, grassy pasture (Sidney, Maine); by treading in an extensive grass and cattail marsh (Belgrade, Maine); under rocks on the gravelly banks of small, shaded streams (Raging River, Washington; Messalonskee Stream, Maine); on sandy river banks in full sun (here in association with *C. oregona* Fall) (Snohomish River, Washington); and on exposed lake beaches of either coarse sand (Katahdin Lake, Maine) or sandy mud (Emigrant Lake, Oregon). The cultivated field and pasture sites are the only ones that resemble Lindroth's (1961) habitat description for the species in North America; the grass/cattail marsh resembles the habitat described by Larochelle (1976). The others represent previously unreported records of the utilization by this species of undisturbed natural habitats on this continent. Such broad ecological tolerance should be expected for a successful colonizer such as this species, but whether the individuals collected represent isolated colonizers or representatives of established, breeding populations has not been determined.

*Localities.* WASHINGTON: King Co.: Raging River, 2 km NNE of Preston/ under rock by stream/ 28-IV-1979/ R. E. Nelson, coll. (1 specimen); King Co./ 3.5 km East of Redmond/ in *Juncus* litter in boggy pasture/ 7-VI-1981/ R. E. Nelson, coll. (2 specimens); Snohomish Co.: Snohomish River, Monroe/ 16-V-1982/ R. E. Nelson, coll. [on sandy river bank in full sun—in company of *C. oregona* Fall] (1 specimen); Snohomish Co.: Snohomish River, Monroe/ 23-V-1982/ R. E. Nelson, coll. [on sandy river bank in full sun—in company of *C. oregona* Fall] (1 specimen); Kittitas Co.: 11 km ENE of Cle Elum/ under log in pasture/ 18-IV-1981/ R. E. Nelson, coll. (1 specimen). OREGON: Jackson Co.: Emigrant Lake/ 22-IV-1982/ R. E. Nelson, coll. [taken under debris on moist, muddy lake shore] (1 specimen). MAINE: Somerset County/ 44.594°N, 69.702°W/ 23-IV-1983/ R. E. & G. M. Nelson, coll. [under stones, margin of cultivated field] (2 specimens); Kennebec Co.: Messalonskee Stream/ 44.568°N, 69.686°W/ 26-V-1983/ R. E. Nelson, coll. [under stone on gravelly, shaded stream margin] (1 specimen); Kennebec Co.: Belgrade/ 44.448°N, 69.834°W/ treading in marsh/ 9-VII-1984/ R. E. Nelson, coll. (1 specimen); Kennebec Co.: Sidney/ 44.447°N, 69.744°W/ under log in pasture/ 27-IV-1986/ R. E. Nelson, coll. (1 spec-

imen); Piscataquis Co.: Katahdin Lake/ 29-VIII-1984/ R. E. Nelson, coll. [coarse, sandy lake margin in undisturbed area] (1 specimen).

#### ACKNOWLEDGMENTS

We would like to thank Chip W. Ridky for collecting and donating the first specimen of *C. auratus* documented in this note. We would also like to thank an anonymous reviewer for careful and critical comments on an earlier version of this manuscript. All specimens of *C. fossor* and a representative short series of *C. auratus* mentioned here presently are in the collection of the senior author. Additional specimens of *C. auratus* will be deposited in the collections of Dr. Sanford R. Leffler (Seattle, Washington), Mr. Paul Johnson (University of Idaho, Moscow), the Museum of Comparative Zoology (Harvard University, Cambridge, Massachusetts), and the California Academy of Sciences, San Francisco. This research was supported in part by a grant from the Natural Science Division of Colby College. Moral support was provided by the Powdermilk Biscuit Company of Lake Wobegon, Minnesota.

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## INFECTIVITY OF EIGHT SPECIES OF ENTOMOGENOUS FUNGI TO THE LARVAE OF THE ELM BARK BEETLE, *SCOLYTUS MULTISTRIATUS* (MARSHAM)

CELESTE HOULE, GEORGE C. HARTMANN, AND S. SALMAN WASTI

Department of Biology, Rhode Island College,  
Providence, Rhode Island 02908

**Abstract.**—Eight species of entomogenous fungi were tested for infectivity to the larvae of *Scolytus multistriatus*. Larvae were inoculated with varying dosages by immersing them in spore suspensions and then incubated at 21°C. High levels of mortality were obtained for most of the test species; *Cordyceps militaris* was not infective under these conditions. Increased spore concentrations of the test fungi did not significantly affect percentage mortality with 7 of the 11 strains of the fungal species tested. Varying temperatures produced complex effects on the host-parasite relationship.

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The vector of Dutch elm disease (DED), *Scolytus multistriatus* (Coleoptera: Scolytidae), has been the focus of control procedures because of its accessibility. It has been reported to be susceptible to several species of entomogenous fungi, including *Beauveria bassiana*, *Metarhizium anisopliae*, *Paecilomyces farinosus*, and *Verticillium lecanii* (Barson, 1976, 1977; Doberski, 1981a, b). Direct control of the causal fungus, *Ceratocystis ulmi*, has been much more difficult because it is found mainly in the host's xylem vessels. *Pseudomonas syringae* has been reported as an effective bacterial antagonist to *C. ulmi* under both *in vitro* and *in vivo* conditions (Holmes, 1954; Myers and Strobel, 1983; Scheffer, 1983). Fungal growth inhibitors of the DED pathogen have been studied by Gibbs and Smith (1978) and Gemma et al. (1984). The objectives of the present study were to demonstrate the infectivity of entomogenous fungi to the DED vector, *Scolytus multistriatus*, under varying experimental parameters. The complementary infectivity of entomogenous fungi to the insect vector and antagonism to the DED pathogen, *C. ulmi*, were also established. Treatment of diseased elms with these entomogenous fungi would initiate simultaneous activity against the vector and the pathogen.

### METHODS

Eleven strains of entomogenous fungal species were evaluated for their infectivity to *Scolytus multistriatus*: *Beauveria bassiana* (Balsamo) Vuill: RS 252, ATCC 26156 (*B. tenella*), and a Russian strain; *Cordyceps militaris* Link: ATCC 26848; *Metarhizium anisopliae* (Metsch.) Sorokin: ATCC 22099; *Hirsutella thompsonii* (Fisher): ATCC 24874; *Nomuraea rileyi* (Farlow) Samson: Missouri strain; *Paecilomyces farinosus* (Dicks. ex Fr.) Brown and Smith: ATCC 24319; *P. fumoso-roseus* (Wise) Brown and Smith: ATCC 16312; *Verticillium lecanii* (Zimm.) Viegas: RH 15-74, ATCC 26854. Stock cultures of each organism were grown on potato-dextrose agar (PDA) with the exception of *N. rileyi* which was grown on Sabouraud maltose agar supplemented with 1% yeast extract (SMYE) and incubated at 24°C for 7 days.

Inoculum for the infectivity studies was prepared by growing each fungal strain on appropriate agar in 10 Petri plates. After 14 days, spores were collected by flooding each of the ten plates with sterile Triton X-100 (0.01%) solution and rubbing off the spores with a bent glass rod. Spore suspensions of each strain were diluted with sterile Triton X-100 (0.01%) solutions to yield the following final concentrations:  $10^3$  spores/ml,  $10^4$  spores/ml, and  $10^5$  spores/ml and used immediately after preparation. Viability of each suspension was confirmed by plating it out on appropriate medium.

Larvae of *Scolytus multistriatus* (Marsham) were obtained from infected elm logs supplied by Dr. John Peacock of the Northeastern Forest Station, Delaware, Ohio. Groups of 30 larvae were washed with 10 ml of sterile Zephiran chloride (1:750) solution for one minute, rinsed with sterile Triton X-100 (0.01%) solution and inoculated with a spore suspension using techniques developed by Doberski (1981a) modified by the insertion of a circular disc, made of fiberglass screening, at the bottom of a syringe barrel to prevent loss of larvae. After inoculation, larvae were transferred to sterile moist chambers; each larva was covered with a sterile vented plastic test tube cap (1.5 cm i.d.). Thirty larvae (10 per moist chamber) were used to replicate each experimental variable tested. Ten larvae inoculated with sterile distilled water served as controls. For each fungal strain, the infectivity of 3 spore concentrations was determined at each of 3 temperatures, 21°C, 25°C, and 30°C.

Inoculated larvae and controls were examined with a binocular dissection microscope at 24 hour intervals. Larvae that failed to respond to prodding with a blunt needle were scored as dead and placed on agar medium containing antibiotics to determine the cause of death. Mortality rates were statistically analyzed using an Analysis of Variance (ANOVA) program. Significant differences were further analyzed using Duncan's Multiple Range Test (Duncan, 1955).

## RESULTS

The percentage mortality of *Scolytus multistriatus* larvae produced by each of the 11 strains of entomogenous fungi at spore concentration of  $10^3$ ,  $10^4$ , and  $10^5$  spores/ml are presented in Table 1. Varying levels of mortality were recorded and *B. bassiana* RS 252, *M. anisopliae* and *P. fumoso-roseus* produced 100% mortality at the highest dosage. Analysis of variance indicated a significant statistical difference between the control and treated larvae. Duncan's (1955) Multiple Range Test showed a significant difference between the controls and the highest dosage. Lowest levels of mortality were produced by *Cordyceps militaris*, *Hirsutella thompsonii* and *Verticillium lecanii* and while higher dosages demonstrated mortality, the differences among the 3 dosages were not significant.

The mortality response based on treatment with  $10^5$  spores/ml at varying temperatures is included in Table 2. Analysis of variance showed significant differences between the controls and the larvae exposed to 3 different temperatures. Duncan's (1955) Multiple Range Test demonstrated significant differences between and within the 3 temperature regimes. *B. bassiana* RS 252, Russian strain, and ATCC 26156; *M. anisopliae*; and *P. farinosus* produced a decrease in percentage mortality at 25°C relative to 21°C and 30°C. Mortalities of those larvae inoculated with *C. militaris* and *P. fumoso-roseus* decreased with decreasing temperature. Inoculation with *N. rileyi* and *V. lecanii* ATCC 26854 resulted in a very slight increase in larval mortality

Table 1. Percentage mortality of *S. multistriatus* larvae 10 days after treatment with surface applied suspensions of fungal spores at 21°C.

Test species	Isolate number	Dosage (spores/ml)			
		Control (0)	10 <sup>3</sup>	10 <sup>4</sup>	10 <sup>5</sup>
<i>B. bassiana</i>	RS 252	10	83	86	100
<i>B. bassiana</i>	Russian strain	23	53	80	90
<i>B. bassiana</i>	ATCC 26156	6	23	23	73
<i>C. militaris</i>	ATCC 26848	30	23	40	36
<i>H. thompsonii</i>	ATCC 24874	10	10	16	46
<i>M. anisopliae</i>	ATCC 22099	6	56	66	100
<i>N. rileyi</i>	Ig-Mo	23	66	73	83
<i>P. farinosus</i>	ATCC 24319	6	10	20	76
<i>P. fumoso-roseus</i>	ATCC 16312	0	33	56	100
<i>V. lecanii</i>	ATCC 26854	13	46	50	56
<i>V. lecanii</i>	RH 15-74	10	10	16	46

F = 14.103.

P &lt; 0.05.

compared to mortality at 21°C and 30°C. *V. lecanii* RH 15-74 caused an increase in percent mortality at both 25°C and 30°C compared to mortality at 21°C.

## DISCUSSION

Four species of fungi, *B. bassiana* RS 252, *H. thompsonii*, *M. anisopliae*, and *P. fumoso-roseus* were significantly more infective when applied at a concentration of 10<sup>5</sup> spores/ml and a temperature of 21°C. Percentage mortalities resulting from the treatment of larvae with the remaining fungal strains did vary significantly with spore concentration. For all strains, percentage mortalities were considerably higher than those of controls at spore concentrations of 10<sup>5</sup>/ml and 10<sup>4</sup>/ml. Only *C. militaris* was non-infective under these conditions.

Temperature seems to have a variable effect on the host-parasite relationship and results are different from those reported for *S. scolytus*. Barson (1977) noted maximum mortality of *S. scolytus* larvae infected with *B. bassiana* at 25°C and a decline in mortality at 30°C. Doberski (1981b) reported higher levels of mortality when experimental temperatures were increased from 2°C to 20°C. Barson (1977) correlated the decrease in infectivity at 30°C with temperature effects on larval growth, the fungus, and growth enhancement of secondary invaders. Similar factors may account for some of the results reported in this study. *S. multistriatus* may have different optimal temperature requirements from *S. scolytus*. Barson (1977) and Doberski (1981b) reported the long term survival of *S. scolytus* larvae at 5°C and 15°C. In this study, a series of tests at 16°C were discontinued because of high control mortality.

Gemma et al. (1984) have reported on inhibitory interactions between *C. ulmi* and 11 strains of entomogenous fungi. *B. bassiana*, *M. anisopliae*, and *N. rileyi* were antagonistic to both aggressive and non-aggressive strains of *C. ulmi* under 4 combinations of light and temperature. One of these fungal species, *M. anisopliae*, showed high infectivity to the vector larvae. Entomogenous fungi that are inhibitory to both the causal agent, *C. ulmi*, and infective to the vector provide a multidimensional



Table 2. Percentage mortality of *S. multistriatus* 10 days after treatment with surface applied suspensions of fungal spores (conc. 10<sup>5</sup> spores/ml) at three incubation temperatures.

Test species	Isolate number	Incubation temperature					
		21°C		25°C		30°C	
		Control	Treated	Control	Treated	Control	Treated
<i>B. bassiana</i>	RS 252	10	100	13	53	20	100
<i>B. bassiana</i>	Russian strain	23	90	36	36	33	93
<i>B. bassiana</i>	ATCC 26156	6	73	6	30	30	83
<i>C. militaris</i>	ATCC 26848	30	36	13	80	16	93
<i>H. thompsonii</i>	ATCC 24874	10	46	23	23	—	—
<i>M. anisopliae</i>	ATCC 22099	6	100	30	46	16	100
<i>N. rileyi</i>	Ig-Mo	23	83	23	86	26	83
<i>P. farinosus</i>	ATCC 24319	6	76	6	50	40	80
<i>P. fumoso-roseus</i>	ATCC 16312	0	100	33	73	40	60
<i>V. lecanii</i>	ATCC 26854	13	56	20	76	20	73
<i>V. lecanii</i>	RH 15-74	10	46	80	83	10	100

F = 29.657.  
P < 0.05.

control program against DED, and this possibility is enhanced by the safety of these fungi to nontarget hosts (Donovan-Peluso et al., 1980; Hartmann et al., 1979; Wasti et al., 1980). Determination of the infectivity of the antagonist—entomopathogen under experimental field conditions would confirm the effectiveness of this multi-dimensional biocontrol program over other unilinear control procedures.

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## AN ATTRACTANT FOR MUSHROOM FLIES (DIPTERA: PHORIDAE)

J. A. KAMM, R. G. BUTTERY, AND W. H. ROBINSON

Forage Seed and Cereal Research Laboratory, USDA Agricultural Research Service,  
Department of Entomology, Oregon State University, Corvallis, Oregon 97331;  
Western Regional Research Center, USDA Agricultural  
Research Service, Berkeley, California; and  
Department of Entomology, Virginia Polytechnic Institute and  
State University, Blacksburg, Virginia 24061

**Abstract.**—Several undescribed *Megaselia* spp. and *M. pluralis* (Wood) in this large genus of mushroom flies were attracted to 1-phenylethanol in field tests. The highest concentration captured the most flies when the concentration ranged from 1–50%. Also, 2-phenylethanol was a weak attractant and captured ca. 10-fold fewer flies than did 1-phenylethanol. A 1:1 ratio of these compounds captured significantly fewer flies than did 1-phenylethanol alone. We predict these compounds will prove to be attractants for other mushroom flies.

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Most phorid flies feed on decaying animal or vegetable matter and play an important role in recycling of nutrients. Members of the genus *Megaselia* occur in a wide range of habitats throughout the world (Robinson, 1971). The mushroom fly, *Megaselia halterata* (Wood), is a well-known member of this taxon because it is a pest of cultivated mushrooms. In fact, a large number of *Megaselia* spp. feed on fungi, and more species may become pests due to increased mushroom production throughout the world (Chang and Miles, 1984). Work is currently underway in Europe to identify volatile components present in mushroom house air capable of modifying oviposition behavior of *M. halterata* (Grove and Blight, 1983). Preliminary field tests identified several compounds with biological activity.

During investigations in search of chemicals that modify behavior of forage pests (Buttery et al., 1982, 1984), a compound was discovered that attracted several species of *Megaselia*. We report here the results of subsequent field tests in several types of habitat containing phorid flies.

### MATERIALS AND METHODS

Field tests were conducted near Corvallis, Oregon, in the following habitats: red clover grown for seed, bluegrass grown for seed, mixed grass pasture, and a grove of oak trees with an understory of litter and mixed grasses. Pherocon 1 C traps were used in all tests with the bait placed in the center of the trap. Baits were prepared by dispensing 1 ml of the test compound (in hexane) into 11 × 17-mm red rubber stoppers (A. H. Thomas Co., Philadelphia, PA 19105) just prior to a test. The dosage of test compound ranged from 1 to 50% based on ml of compound per ml of hexane. Four replicates of each test concentration were exposed in the field at each test site in a randomized block design. Traps were positioned at least 20 m from other traps. Each replicate included an unbaited check trap that contained a stopper impregnated



Table 1. Number of *Megaselia pluralis* (Wood) in Pherocon 1 C traps ( $\pm$  standard deviation) baited with 10% 1-phenylethanol in different habitats.

Date	Red clover	Bluegrass	Understory in stand of oak	Mixed grass pasture
April 30–May 4	0	4 (1)	0	80 (4.2)
June 5–11	45 (8.3)	0	0	162 (14.5)
July 9–13	118 (14.9)	66 (14.7)	453 (1.51)	227 (15.6)
August 6–10	346 (7.23)	6 (1.1)	189 (1.31)	99 (10.6)
September 10–14	8 (0.7)	13 (3.1)	26 (1.9)	57 (8.7)

with hexane only. In the habitat test, traps were deployed in each field for 5 days during the first week of each month from May through September.

#### RESULTS

The initial discovery that 1-phenylethanol was an attractant for phorids was made in a field of red clover. A subsequent test was made in the same field to confirm the observation and determine the effect of dosage on trap catch. This test included traps baited with 1, 5, 10, and 50% 1-phenylethanol and unbaited check traps. During September 21–26, 1983, four traps of each dosage captured 80, 377, 823, 1,145, and 11 *Megaselia* spp. specimens, respectively. At least three *Megaselia* species were captured and all were undescribed species. Voucher specimens of all species captured in these studies are in the insect collection at Virginia Polytechnic Institute and State University.

In 1984, a second test was conducted on different types of habitat using baits of 10% 1-phenylethanol. The only phorid captured in all habitats was *Megaselia pluralis* (Wood) (Table 1). Based on these captures, the species was most abundant from June–August with an apparent peak in numbers during July. All habitats sampled revealed some *M. pluralis*, which suggests that the species is common in many types of habitat throughout the Willamette Valley of Oregon. This species has a wide distribution and occurs in a large number of habitats (Robinson, 1981).

In an attempt to increase trap catch, we decided to test 1-phenylethanol, in combination with the related compound 2-phenylethanol, a known attractant for anthomyiid flies (Ishikawa et al., 1983). Four traps of each dosage and/or combination shown in Table 2 were exposed in the field for three days during mid-August 1984. The 2-phenylethanol alone was a weak attractant compared with 1-phenylethanol. None of the combinations of 1- and 2-phenylethanol produced trap catches comparable to 1-phenylethanol alone.

#### DISCUSSION

These tests have shown that 1-phenylethanol is an attractant for both sexes of a number of species of *Megaselia* also known as mushroom flies. Flies definitely initiated upwind anemotaxis in response to 1-phenylethanol and were capable of following a concentration gradient to the source in a trap. However, many flies did not enter the trap and instead aggregated in the vicinity of the trap, which suggests that

Table 2. Capture of *Megaselia pluralis* (Wood) in Pherocon 1 C traps baited with 10% 1-phenylethanol, 10% 2-phenylethanol or combinations in different ratios.

ml/bait		No. captured*
1-phenylethanol	2-phenylethanol	
1	0	510 a
0	1	34 b
0.1	0.9	98 c
0.9	0.1	266 d
0.5	0.5	330 d

\* Means followed by the same letter do not differ significantly.

1-phenylethanol may function as an aggregation attractant. Grove and Blight (1983) reported several compounds unrelated to 1-phenylethanol as having some activity on *M. halterata* but found no 1-phenylethanol in mushroom house air. However, both 1- and 2-phenylethanol and also the closely related acetophenone occur in mushrooms (Pyysalo, 1976; Yajima et al., 1981). None of these compounds has the type odor commonly associated with mushrooms. At present, 1-phenylethanol appears to be the most potent known attractant for *Megaselia* spp. with the possible exception of the sex pheromone of *M. halterata* (Baker et al., 1982).

We suspect that 2-phenylethanol may be an attractant for other species of *Megaselia* because of the inhibitory effect on trap catch in our tests when used in combination with 1-phenylethanol, indicating a sensitivity to both compounds. Often related compounds have similar functions in other species. Indeed, 1- and/or 2-phenylethanol may prove to be an attractant for other *Megaselia* species, including the mushroom fly. We predict that 2-phenylethanol will prove as attractive to other species of *Megaselia* as 1-phenylethanol is to *M. pluralis* and the undescribed species captured in our tests.

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## A DESCRIPTION OF THE MATURE LARVA AND COCOON OF THE BEE *THYGATER* (HYMENOPTERA; ANTHOPHORIDAE)

LAURENCE PACKER

Department of Zoology, University of Toronto,  
Toronto, Ontario M5S 1A1, Canada<sup>1</sup>

*Abstract.*—The larva and cocoon of an undetermined species of the eucerine bee *Thygater* are described and the larva illustrated and compared with those of other eucerine genera. The conservatism in morphology exhibited by eucerine larvae extends to this genus.

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During the course of excavations of the nests of halictine bees at Ocosingo, Chiapas, Mexico in January 1985 (Packer, 1985) three cocoons of an undetermined bee species were unearthed. Upon later dissection, two fully grown larvae and a partly decomposed adult female bee were found inside the cocoons. The bee has been identified by Professor C. D. Michener as a member of the genus *Thygater*. Unfortunately, its poor condition makes it impossible to identify to the species level. According to the larval apoid catalogue produced by McGinley (unpubl.), larvae of this genus have not been previously described, although the nest architecture of one species, *Thygater analis*, has been studied by Rozen (1974). This paper is the first description of the larva of a bee of this genus. Additional comparative notes are made between the larva of *Thygater* and those of other eucerine species.

### NEST STRUCTURE

The nest site has been described elsewhere (Packer, 1985). The *Thygater* cells were discovered at a depth of about 60 cm. It is not known whether the nest entrance had been in level ground or in the vertical side of the bank. Because the cells were discovered accidentally, few details of the nest architecture are available. The cells were oriented vertically and placed singly at the ends of short vertical burrows that probably represented two separate branches from the main entrance burrow. The nest architecture appears to be similar to that of *Thygater analis* (Rozen, 1974) and other eucerines (Bohart, 1964; Miliczky, 1985; LaBerge and Ribble, 1966; Rozen 1964, 1969, 1974).

### DESCRIPTION OF LARVA

The following description is in the format of Rozen (1965) and is based upon 2 mature, predefecating larvae that were preserved in alcohol. Because of time constraints on the day of excavation, no detailed description of the shape of the larvae was made. Furthermore, because of poor fixation, the preserved larvae do not retain

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<sup>1</sup> Present address: University College of Cape Breton, P.O. Box 5300, Sydney, Nova Scotia B1P 6L2, Canada.



their original overall shape. Nonetheless, in general habitus the larvae are of typical eucerine shape.

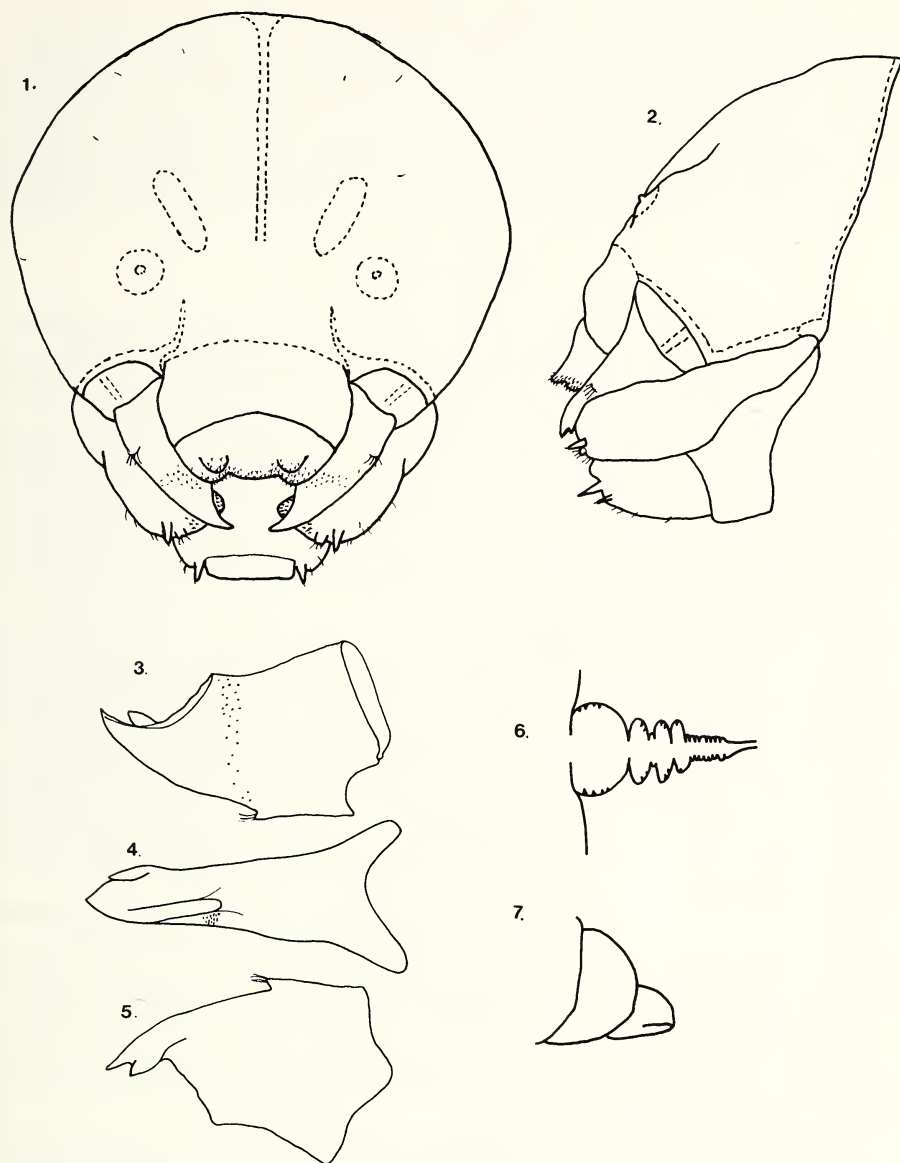
Head (Figs. 1, 2): Integument with a very few, short setae on head capsule, labium and maxillae; epipharyngeal and apical-dorsal surfaces of labrum, including labral tubercles, and apices of maxillae minutely spiculate; mandibular apices and articulations darkly pigmented; hypostomal ridges, labial and maxillary palpi, salivary lips and galeae weakly pigmented; abductor apodeme of mandible lightly pigmented and visible through mandibular corium in uncleared specimens; adductor apodeme with only a very small, apical section pigmented. Anterior and posterior tentorial arms and tentorial bridge well developed; dorsal arms less well developed, gradually narrowing to apex; posterior thickening of head capsule narrowly developed; pleurostomal and hypostomal ridges well developed; epistomal ridge weakly developed; median thickening well developed dorsally becoming weaker ventrally and disappearing below level of antennae (weakening is a result of the thickening becoming less deep, not less broad). Parietal band not visible. Broad depression evident between each antenna and median thickening. Antennal prominence low; papilla approximately three-quarters as long as basal diameter. Clypeus more than two and one-half times as broad as median length; median length subequal to that of labrum; clypeo-labral suture distinct throughout. Labrum short, more than twice as broad as median length; labral tubercles fairly well developed; lateral lobes extending beyond both labral tubercles and median lobe ventrally. Mandibles (Figs. 3–5) massive; dorsal surface with a few very short setae which form band at level of beginning of apical darkening; dorsal surface irregular but not denticulate; mandibular apex bidentate, both teeth sharp-pointed, dorsal tooth longer; aboral surface with well developed prominence that bears 3 or 4 strong setae. Maxillae broadly rounded apically, prolonged adorally with mesial surface rounded and dorsal oral surface straight; galeae shorter than basal diameter, appearing weakly bi- or tri-lobed; base of galea three-quarters as wide as base of maxillary palpus; maxillary palpus twice as long as its basal width. Width of prementum less than half that of the postmentum viewed from beneath, salivary lips broad, projecting, more than three times as wide as median length (upper and lower lips of equal length); labial palpi three times as long as basal width, only three quarters as long as maxillary palpi.

Body: Predefecating larva robust, body strongly C-shaped. Integument devoid of spicules and setae, without obviously sclerotized areas. Spiracular atrium (Fig. 6) with four rows of tiny denticles; outer subatrium with three or four sections, each bearing one or two rows of denticles; outer rim of atrium projecting very slightly above general body surface. Tenth abdominal segment (Fig. 7) with anus apical, dorsal surface strongly convex.

A deutonymph of a histiostomatid mite was discovered on the body of one of the larvae.

#### COCOON

The cocoon was almost identical to that described for *Svastra obliqua obliqua* (Rozen, 1964) and *Tetralonia* (Rozen, 1969; Miliczky, 1985). There were three layers, the outer one was thin and "earthen" and probably represents the cell lining. The middle layer was red-brown and the inner layer amber and composed of fibers. The



Figs. 1-7. *Thygater* sp. mature larva: 1. Head—anterior view. 2. Head—lateral view. 3-5. Right mandible—dorsal, inner and ventral views. 6. Spiracle. 7. Apex of abdomen.

roof of the cocoon contained silken partitions with air spaces, as described for *S. obliqua* (Rozen, 1964), *Tetralonia minuta* (Rozen, 1969) and *Thygater analis* (Rozen, 1974). However, the roof was not as thick as that of *S. obliqua*, appearing more similar to those of *Tetralonia*.

Material examined. Two mature, predefecating larvae and two cocoons from Ocosingo, Chiapas, Mexico, collected on the 25th of January, 1985. Larvae and cocoons are in the collection of the author, the mite has been placed in the Cornell University Insect Collections under GCE #86-0212-2.

#### DISCUSSION

As noted by Rozen (1965), and confirmed by McGinley (1981, plate 22), there is little diversity in the morphology of the mature larvae of eucerine bees. Adult eucerines also exhibit little diversity, although *Thygater* is one of the more distinctive genera (Michener, pers. comm.). The larva of *Thygater*, described here for the first time, indicates that the morphological conservatism of the larvae extends to this genus. Nonetheless, the larva of *Thygater* does show some differences from the other known eucerine larvae and these are described below. In the following discussion, data for other eucerines comes from the following sources—*Melissodes* sp. (Michener, 1953), *Svastra* (Rozen, 1964), *Xenoglossa*, *Melissodes pallidisignata* and *Peponapis* (Rozen, 1965), *Florilegus* (LaBerge and Ribble, 1966), *Tetralonia minuta* (Rozen, 1969) and *T. hamata* (Miliczky, 1985).

The frontal outline of the head capsule is quite round, with only a narrow flattened area dorsally. The larvae of *Xenoglossa*, *Peponapis* and *Melissodes pallidisignata* appear similar in this respect, whereas that of *Florilegus* is widely flattened dorsally and those of *Svastra*, *Tetralonia* and *Melissodes* sp. are concave. The median thickening of the head capsule does not reach the epistomal suture. In this feature *Thygater* is similar to the larvae of *X. angustior*, *X. fulva* and *Tetralonia hamata*, but unlike the latter two species the thickening disappears by becoming gradually less deep rather than by tapering to a point. The depressions between the antennae and median thickening have not been reported for any other eucerine species.

The labrum of *Thygater* has the lateral lobes extending beyond the median lobe and the labral tubercles. In this respect *Thygater* appears to be similar to the larvae of *X. fulva*, *X. strenua*, *Peponapis* and *M. pallidisignata*. The other species either have the labral tubercles, median lobe or both extending beyond the lateral lobes.

The mandibles have a very well developed, seta bearing ridge on the aboral surface. Only the *Melissodes* described by Michener has such a strongly projecting ridge. The apices of the maxillae are prolonged adorally as in *Xenoglossa* and *Peponapis* but not as acutely as in *Svastra*.

The dorsal surface of the tenth abdominal segment of *Thygater* is more strongly and uniformly convex than in any of the other species.

In the tentative key to eucerine larvae produced by Rozen (1965) *Thygater* runs to the second half of the third couplet, along with *Xenoglossa fulva*, *X. strenua* and *Peponapis fervens*. *Tetralonia hamata* probably runs to this point also. The larva of *Thygater* can be distinguished from all of these species by the strongly projecting aboral mandibular ridge.

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NESTING BIOLOGY OF THE SQUASH BEE  
*PEPONAPIS UTAHENSIS*  
(HYMENOPTERA; ANTHOPHORIDAE; EUCERINI)

JEROME G. ROZEN, JR. AND RICARDO AYALA

The American Museum of Natural History, Central Park West & 79th St.,  
New York, New York 10024 and  
Estación de Biología Chamela, UNAM, Apartado Postal 21,  
San Patricio, Jalisco 48980, México

**Abstract.**—Information is presented on nest architecture, provisioning, ontogeny and certain other aspects of the natural history of the squash bee *Peponapis utahensis* (Cockerell) and compared with what is known about other species in the genus.

**Resumen.**—Se presenta información sobre la arquitectura de los nidos, aprovisionamiento de la celda, ontogenia y otros aspectos de la historia natural de la abeja de la flor de calabaza *Peponapis utahensis* (Cockerell). Estos datos son comparados con la información conocida para otras especies de este mismo género.

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We present the following information on *P. utahensis* (Cockerell) to expand the understanding of the behavior and ecology of the bee genus *Peponapis*, all species of which are believed to pollinate squashes and gourds (*Cucurbita*). Heretofore, the nesting biologies of only *Peponapis pruinosa* (Say) (Mathewson, 1968) and *P. fervens* (Smith) (Holmberg, 1884; Michener and Lange, 1958) have been described.

OBSERVATIONS

**Description of nesting site.** This species visited flowers of an unidentified species of *Cucurbita* of the *sororia* group<sup>1</sup> and nested at Chamela, Jalisco, Mexico. We discovered the first nest entrance on October 1, 1985, but subsequent rains obliterated it before excavation. The second nest, found on October 6, was within 30 m of the first, and we encountered a third adjacent to the second one during our excavations on October 8, 1985. All nests occurred in a partly cleared, horizontal area (Fig. 1) in the woods adjacent to Arroyo Chamela, within 100 m of the closest *Cucurbita* patch. The forest canopy shaded all three entrances for most if not all of the day, and herbaceous vegetation 30 cm high also partly obscured two of the entrances. The soil was homogeneous, moist, loose, coarse sand, with little organic content except for a few roots, from the surface to a depth of about 40 cm, below which it became finer, more clay-like and compact.

Many other species of bees occurred in the area, including *Xenoglossa gabbii* (Cresson), which visited the same food plants as *Peponapis*. Considering the large

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<sup>1</sup> *P. utahensis* has also been observed at the flowers of *Cucurbita pepo*, *Luffa* sp., *Schizocarpum longisepalum* Jeffrey (all Cucurbitaceae) and *Ipomea nil* Roth (L.) and *Ipomea* sp. (Convolvulaceae).

number of *Peponapis utahensis* foraging early in the morning, we must not have discovered the main nesting area. Although *Triepeolus*, *Epeolus*, and *Odyneropsis* were collected in the region, no parasitic bees flew around the nest entrances, and we did not recover their immatures in excavated cells.

*Description of nest.* Although we did not observe the opening to the third nest, the entrances of the other two were unplugged and surrounded by small concentric tumuli. Just below the surface, the main tunnel of the second nest (Fig. 2), 7.0 mm in diameter, gave rise to a short lateral (antechamber) several centimeters long, extending horizontally and ending blindly. The open main burrow meandered slightly but descended generally vertically. Whereas the burrow of the second nest was being constructed and was open its entire length, that of the third nest was filled with sand so that it was not detectable except below, where the finer substrate contrasted with the coarser sand fill. At the depth of 50 cm, the open burrow of the second nest widened and an open lateral extended outward about 5 cm and rose about 1.5 cm before bending downward and connecting to an open, partly provisioned cell. The wall of the lateral was unlined and absorbed water readily when tested. Filled laterals (Figs. 2, 3) leading to completed cells were indistinguishable from the substrate.

All cells (Fig. 4) were vertical and arranged singly. Radially symmetrical, they were elongate, 8.0–9.0 mm in maximum diameter (4 measurements) and 14.0–15.0 mm long (2 measurements from bottom of cell to rim of closure). They gradually and evenly widened from their mouths (7.0 mm in diameter) to their maximum diameters about 5 mm from the bottoms. The lower part of each cell was broadly rounded. Hence their general shape and appearance were similar to that of other eucerines familiar to us.

We encountered eight cells, all between the depths of 48 and 56 cm; some of these were associated with the third nest. Cells (Fig. 3) ranged from 5.0 to 15.0 cm from the main tunnel.

Cell walls were smooth, darker than the substrate on excavation, and not certainly plastered, although in some cases the soil immediately adjoining the lining seemed slightly denser than the substrate. (In cells of some taxa, the female seems to make a large excavation and then plasters the surface with a thick, smooth wall that, on drying, is distinct from and harder than the substrate. The actual process is not fully understood.) The lining was shiny, semitransparent, and extended from the bottom of the cell upward about 15 mm, to the level where the cell (or burrow) wall became rougher. The lining was waterproof when tested with a droplet.

Several cell closures were deeply concave spirals of coarse soil on the inside with about 5 rows to the radius. Closures did not exhibit a smooth outer surface distinct from the fill of the lateral, as is the case with certain other anthophorids such as *Exomalopsis* (Rozen, 1984).

*Provisioning and development.* The yellow provisions were generally mealy-moist, although they may have become quite liquid on the surface in older cells. The provisions contained air spaces (vaculated) as with many other eucerines, but the strong cheesy odor often encountered in nests of other tribal members was scarcely noticeable. The pollen grains were large and uniform in size and shape.

We did not encounter eggs, but did find small and intermediate larvae on top of the provisions, feeding around the periphery. A large intermediate larva (Fig. 4) rested on its side as it fed, and had created a central pillar of provisions.



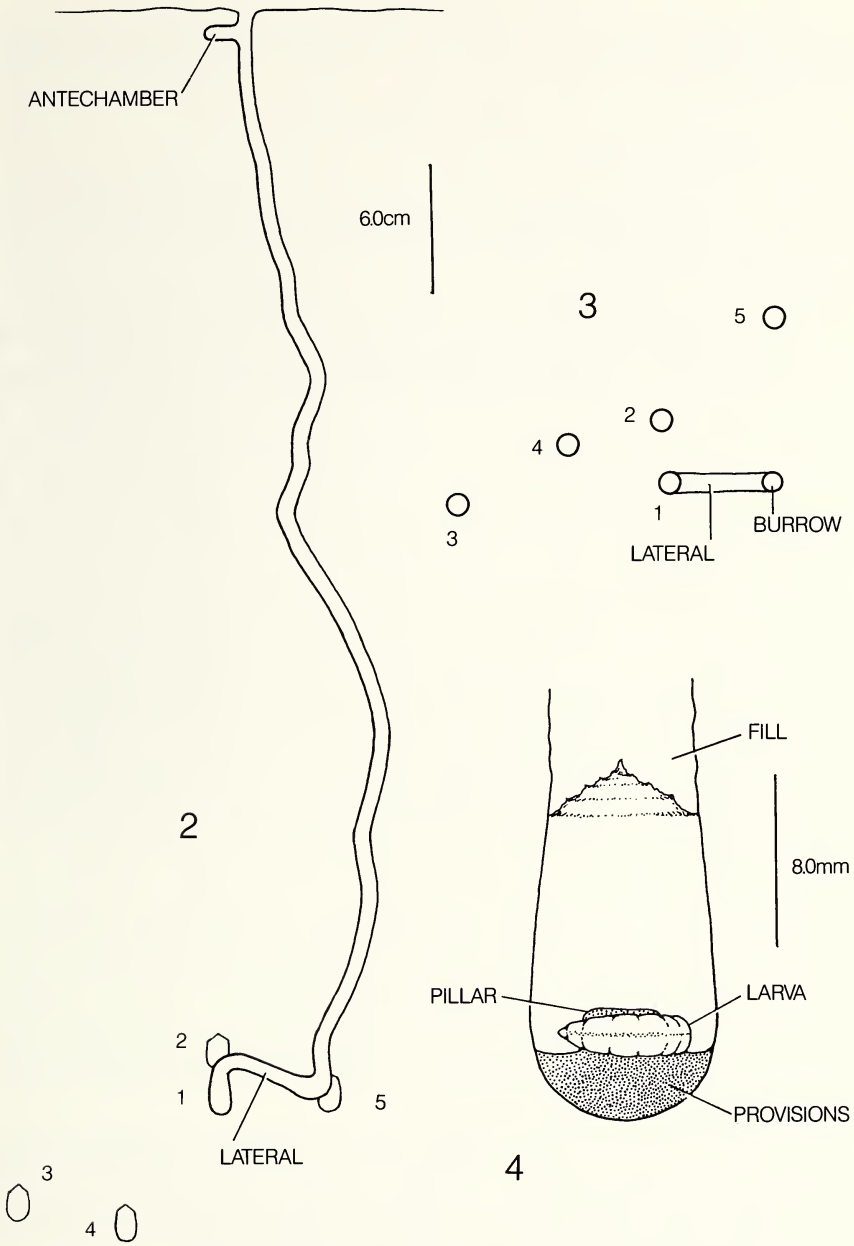
Fig. 1. Ricardo Ayala excavating nest of *Peponapis utahensis* at Chamela, Jalisco, Mexico.

A single mature larva had started to defecate by placing elongate yellow fecal pellets overhead against the cell closure, as has been seen in other eucerines. No cocoons were encountered, but the larva possessed projecting salivary lips, an anatomical feature associated with cocoon production.

*Daily and seasonal activity.* This species flew early in the morning. On October 1, we heard the first females on the open flowers at about 6:30 a.m. when it was still too dark to see them. Their greatest period of activity extended between 6:30 and 7:00 a.m., at which time we could observe them together with the *Xenoglossa gabbii*, a less abundant species at Chamela. Charles D. Michener (in lit.) collected "one or two in flight about 10:00 a.m., and two males in closed flowers at midday."

*Peponapis utahensis* as well as other species in the same genus and *Xenoglossa gabbii* were active only from September to the first days of November, coinciding with the flowering of Cucurbitaceae and Convolvulaceae in the region.





Figs. 2-4. 2. Nest of *Peponapis utahensis*, side view. 3. Same, top projection at cell level. 4. Diagram of closed cell showing closure, provisions, and feeding intermediate stage larva, side view. Scales refer to Figures 2 and 3, and 4, respectively.



## DISCUSSION

We can compare the nesting biology of three species of *Peponapis*, as follows: *Peponapis (Peponapis) pruinosa* (Mathewson, 1968), *P. (Colocynthophila) fervens* (Holmberg, 1884; Michener and Lange, 1958), and *P. (Eopeponapis) utahensis* (present paper). As indicated, each species belongs to a different subgenus, as recognized by Hurd and Linsley (1970).

All three species nest in flat or nearly flat ground in the general vicinity of the pollen source, *Cucurbita*, and apparently only a single female occupies a nest. Whereas *utahensis* nests were shaded, those of *fervens* and apparently also *pruinosa* were exposed to the sun.

Burrow entrances of all species are normally surrounded by concentric tumuli, and main burrows of nests under construction are open. For *utahensis*, there is an indication that burrows of completed nests are filled. Females of both *utahensis* and *pruinosa* construct short blind horizontal tunnels (antechambers) connecting to the main tunnel just below the ground surface, but antechambers are not reported for *fervens*. The main burrow of *fervens* is described as vertical and very straight; of *pruinosa*, vertical but sometimes taking "a spiral course to circumvent buried obstacles"; for *utahensis*, meandering slightly but generally descending vertically through a homogeneous substrate. Cells of *fervens* were found 20–60 cm deep by Michener and Lange (1958) and 12 cm by Holmberg (1884); those of *pruinosa*, 12–22 cm; and those of *utahensis*, 48–56 cm. Cells occur 4–7 cm from the main burrow in *fervens*, within 12 cm in *pruinosa*, and 5–15 cm in *utahensis*. Laterals ascend somewhat before connecting to cells in *fervens* and *utahensis*, but descend in *pruinosa*. With all species, laterals are filled with soil after cell closure. Cells of all three species (and indeed of all eucerines familiar to us) are vertical and radially symmetrical. Cells of *fervens* and *utahensis* are about the same size (8–9 mm in maximum diameter, 14–16 mm long); those of *pruinosa* are slightly smaller (6.5–7 mm in diameter, 13 mm long). Although none of the species exhibited clearly plastered cell walls, those of *fervens* are reported to be harder than the substrate. Cell linings are somewhat shiny in all cases.

In all three species, the provisions are placed in the bottom of the cell. Consistency of the food at the time of deposition needs further study as do changes in consistency through time. Information on the cell closure of *pruinosa* is missing, but the closure of *fervens* is "rough on the inside and shows no spiral pattern," and that of *utahensis*, deeply concave on the inside and with a distinct spiral. We predict that further observations will reveal that all *Peponapis* have spiral, deeply concave cell closures. All three species place their feces against the inner surface of the closure, and undoubtedly all three spin cocoons.

Hence, in most respects nest architecture, cell provisioning, and ontogeny of these three species are similar. The above information suggests that there may be meaningful differences from one species to another with respect to certain features, such as choice of nest site, depth of nests, compactness of cell arrangement in a nest, cell size, inclinations of lateral tunnels, and consistency of provisions.

## ACKNOWLEDGMENTS

This paper is an outgrowth of the Programa Cooperativo sobre la Apifauna Mexicana (PCAM). We wish to thank the officials of the Estación de Biología Chamela in Jalisco, Mexico, especially

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## NEOTROPICAL MIRIDAE, CCXXXIV: NEW SPECIES OF RESTHENINI (HEMIPTERA)

J. C. M. CARVALHO AND J. C. SCHAFFNER

Museu Nacional, Rio de Janeiro, R. J., Brazil and  
Department of Entomology, Texas A&M University,  
College Station, Texas 77843

*Abstract.*—The following species are described as new: *Prepopsoides jaliscoensis* from the state of Jalisco, Mexico; *Prepops bicoloroides* from the state of Oaxaca, Mexico; *Prepops englemanni* from Panama; *Prepops nicaraguensis* from Nicaragua; *Prepops nuevoleonensis* from the state of Nuevo Leon, Mexico; *Prepops vittatus* from the state of Campeche, Mexico; *Oncerometopus mexicanus* from the states of Zacatecas and Mexico, Mexico; *Platytylus binotatus* from the state of Jalisco, Mexico; *Platytylus rubriventris* from the state of Oaxaca, Mexico; and *Platytylus veracruzensis* from the state of Veracruz, Mexico.

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The tribe Resthenini as it exists in the Western Hemisphere has been rather thoroughly reviewed during recent years in papers by Carvalho and Fontes (1969a, b, 1970a, b, c, 1971a, b, c, d, e, f), Carvalho (1974a, b, c, 1975, 1976) and Carvalho and Schaffner (1974a, b, 1975). Since the publication of these papers, undescribed forms have continued to appear in collections. The purpose of this paper is to add some of these species to our knowledge of the tribe.

### *Prepopsoides jaliscoensis*, new species

Fig. 1

*Description.* Female (holotype). Length, 9.88 mm; width, 3.12 mm. Head length, 0.60 mm; width through eyes, 1.44 mm; vertex width, 0.68 mm. Length of antennal segment I, 1.56 mm; II, 2.92 mm; III, 2.16 mm; IV, 1.68 mm. Pronotal length, 1.80 mm; width, 2.60 mm. Cuneal length, 1.44 mm; width, 0.76 mm.

General coloration black with red and pale yellow areas; head red with clypeus and area of frons immediately adjacent fuscous to black; basal segment of antenna light fuscous, remaining segments dark fuscous to black; second segment of rostrum lutescent, remaining segments fuscous to black; pronotum red with black spot behind each callus; mesoscutum and scutellum red; remainder of thorax red; hemelytron black with embolar area and outer margin of cuneus pale yellow; coxae red, remainder of legs light fuscous with apices of tibiae black, tarsi black; abdomen red, valvula black.

Rostrum reaching mid coxae. Pubescence short and dense. Antennal segments I and II with some dark erect hairs at least twice as long as diameter of segment. Femur with dark erect hairs almost as long as diameter of femur. Basal  $\frac{2}{3}$  of tibiae with dark erect hairs much longer than diameter of tibia with hairs becoming shorter, more dense and less erect on apical  $\frac{1}{3}$ . Abdomen with erect light hairs.

Male unknown.

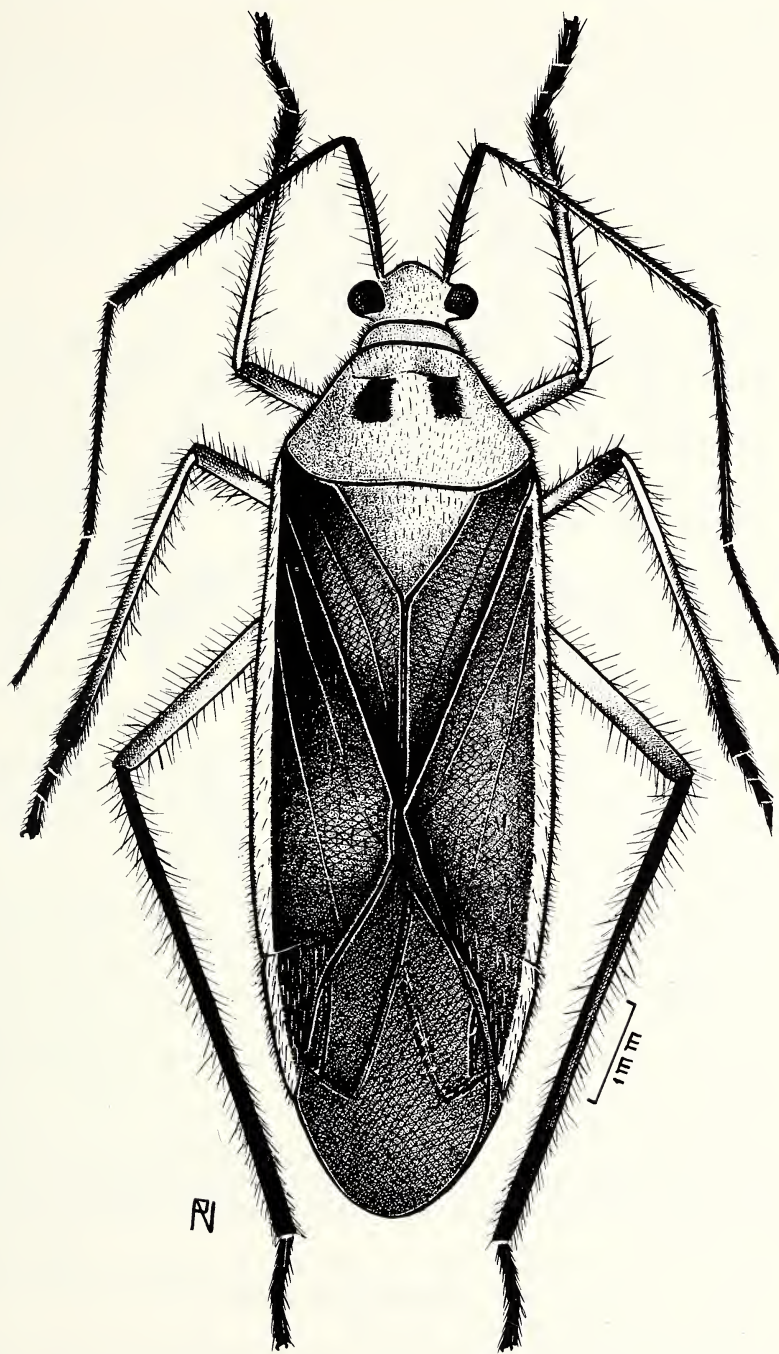


Fig. 1. *Prepoposoides jaliscoensis*, female.



*Holotype*. ♀, MEXICO: Jalisco, 14 miles S of Autlan, August 3, 1978, Plitt and Schaffner. Deposited in the National Museum of Natural History, Washington, D.C.

*Paratypes*. ♀, same data as holotype; 3 ♀♀, Jalisco, 15 mi SW Autlan, July 15, 1983, Kovarik, Harrison, Schaffner. Deposited in the collection of the Department of Entomology, Texas A&M University, College Station, Texas.

The species is named after the Mexican state in which it was collected.

*Prepops occidentalis* Carvalho and Schaffner is hereby transferred to *Prepopsoides*, **New Combination**. The members of the genus *Prepopsoides* can be easily distinguished as follows:

1. Pronotum with fuscous or black markings ..... 2
- Pronotum uniformly lutescent to red ..... *schumanni* (Distant)
2. Hemelytron black with embolium and outer margin of cuneus light; over 9 mm in length ..... 3
- Hemelytron light fuscous, embolium occasionally slightly lighter; cuneus lighter varying to almost entirely orange; less than 7 mm in length ..... *occidentalis* (Carvalho & Schaffner)
3. Scutellum with basal corners fuscous ..... *binotatus* Carvalho & Schaffner
- Scutellum uniformly red ..... *jaliscoensis*, n. sp.

The genus *Prepopsoides* differs from other genera of the tribe Resthenini by having prominent, long, dense hairs on the basal two antennal segments, the tibiae and the apices of the femora. The head and pronotum lack the long setae.

### ***Prepops bicoloroides*, new species**

Figs. 2–5

*Description*. Male (holotype). Length, 7.04 mm; width, 2.48 mm. Head length, 0.40 mm; width through eyes, 1.44 mm; vertex width, 0.52 mm. Length of antennal segment I, 0.80 mm; II, 3.00 mm; III, 1.32 mm; IV, 1.24 mm. Pronotal length, 1.16 mm; width, 1.80 mm. Cuneal length, 1.08 mm; width, 0.64 mm.

General coloration black with reddish lutescent areas; head with clypeus fuscous, remainder reddish lutescent; first antennal segment fuscous, becoming darker apically, remaining segments black; rostrum fuscous; pronotum as seen from above black with collar, area of calli with continuous triangular middorsal inflection and sides reddish lutescent; mesoscutum light fuscous; scutellum and hemelytron black; coxae lutescent; trochanters lutescent to fuscous, remainder of legs fuscous to black; pleural and sternal regions of thorax and abdomen lutescent; apex of genital capsule and parameres fuscous to black.

Rostrum reaching hind coxae. Body with very short pubescence, almost glabrous, hairs of antennae very short, those of tibiae and femora longer.

*Genitalia*. Vesica (Fig. 3) with several sclerotized spiculi and membranous lobes; left paramere (Fig. 5) falciform; right paramere (Fig. 4) small, curved at apex.

Female unknown.

*Holotype*. ♂, MEXICO, Oaxaca, 1.6 mi north of Putla, August 3, 1976, Peigler, Gruetzmacher, R. & M. Murray, Schaffner. Deposited in the National Museum of Natural History, Washington, D.C.

*Discussion*. This species closely resembles *P. bicolor* (Distant) in color as well as color pattern. The head of *P. bicoloroides* does not project as far anteriorly as does

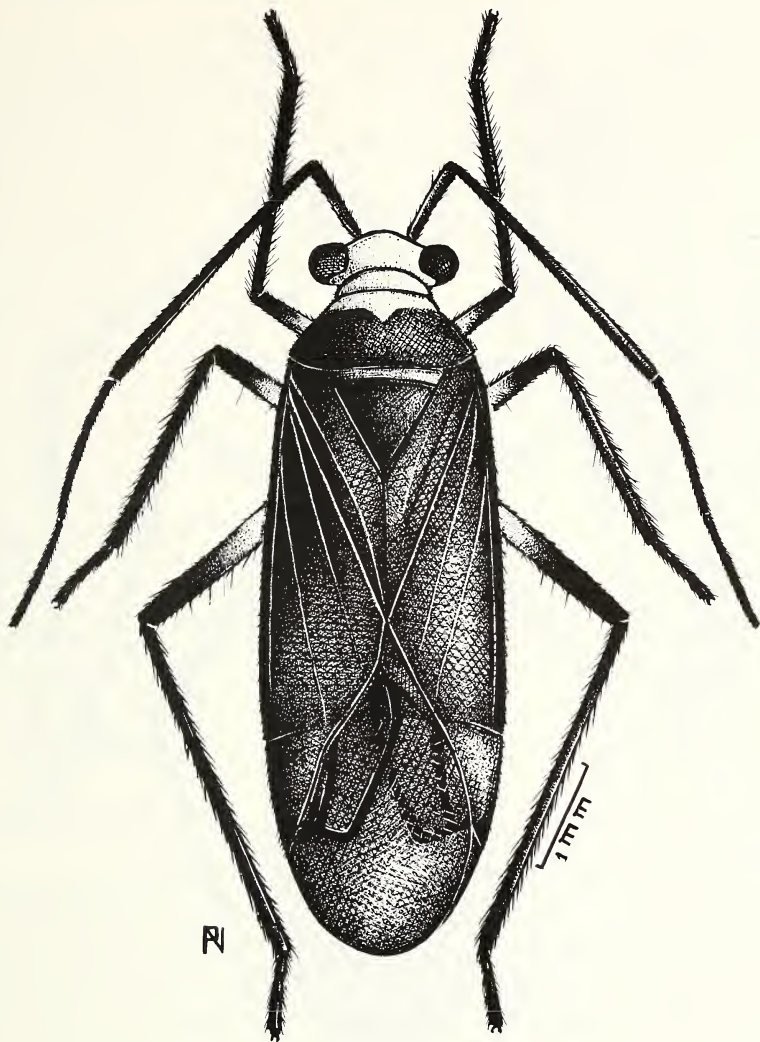


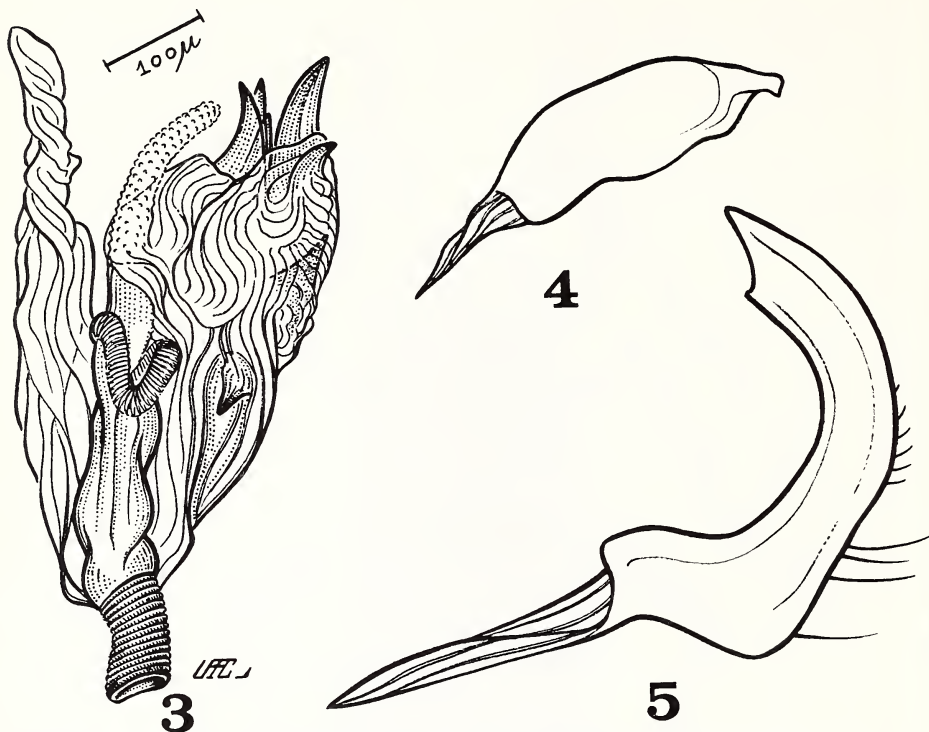
Fig. 2. *Prepops bicoloriodes*, male.

that of *P. bicolor* and the femora are primarily shades of fuscous rather than orange or lutescent as in the case of the latter species. The overall size of *P. bicoloriodes* is smaller. The first antennal segment is 0.8 mm in length while in *P. bicolor* it is longer than 1.0 mm.

***Prepops englemani*, new species**

Figs. 6-9

*Description.* Male (holotype). Length, 7.60 mm; width, 2.36 mm. Head length, 0.44 mm; width through eyes, 1.52 mm; vertex width, 0.80 mm. Length of antennal



Figs. 3–5. *Prepops bicoloriodes*. 3. Vesica. 4. Right paramere. 5. Left paramere.

segment I, 1.56 mm; II, 3.20 mm; III, 2.44 mm; IV, 1.92 mm. Pronotal length, 1.70 mm; width, 2.44 mm. Cuneal length, 1.16 mm; width, 0.60 mm.

General coloration black and lutescent; head reddish lutescent with clypeus, apex of lorum, broad area of vertex, small areas behind antennal socket and behind eye black; antennae black; rostrum fuscous to black; anterior region of pronotum lutescent, area posterior to calli black with narrow reddish lutescent line at interface between lutescent and black coloration; mesoscutum and scutellum lutescent; hemelytron black, pleural and sternal regions of thorax lutescent; bases of coxae reddish lutescent, remainder of legs dark fuscous to black; abdomen reddish lutescent.

Rostrum reaching mid coxae. First antennal segment longer than width of head. Pubescence of body extremely short, appearing glabrous above.

*Genitalia*. Vesica (Fig. 7) with three lobes with apical sclerotization; left paramere (Fig. 9) long, falciform, apex spine-like; right paramere (Fig. 8) small, pointed apically; pygophore without lateral prongs.

Female (paratype). Length, 8.60 mm; width, 2.92 mm. Head length, 0.60 mm; width through eyes, 1.68 mm; vertex width, 0.88 mm. Length of antennal segment I, 1.68 mm; II, 3.36 mm; III, 2.64; IV, missing. Pronotal length, 1.68 mm; width, 2.52 mm. Cuneal length, 1.36 mm; width, 0.68 mm.

Similar to male in color and form.

*Holotype*. ♂, PANAMA, B de T, Rio Changuinola, 9°17'N, 82°32'W, 24–27 Jan.

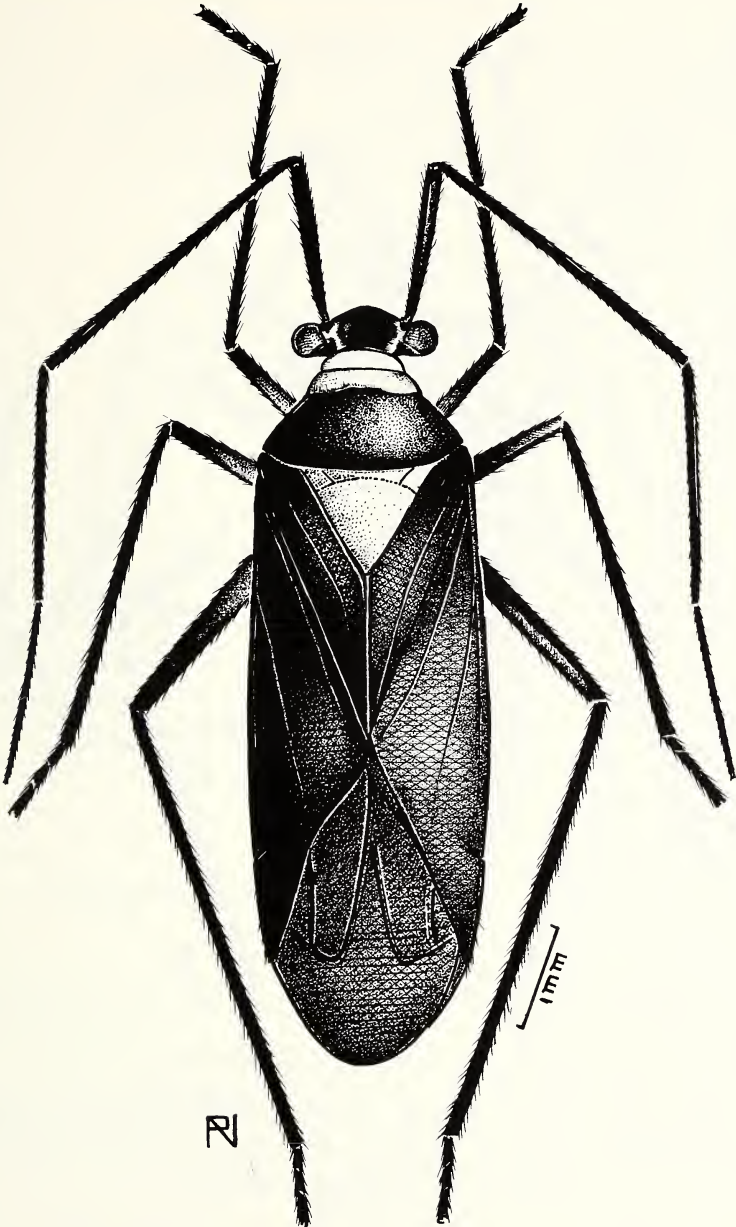
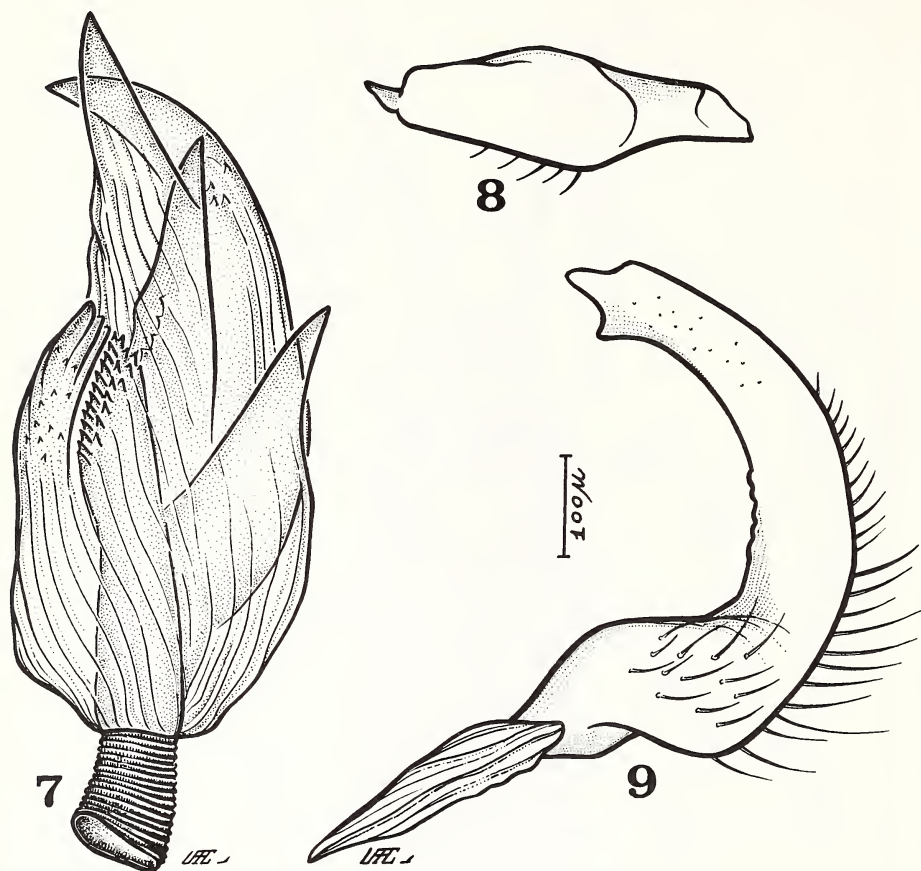


Fig. 6. *Prepops englemani*, male.





Figs. 7-9. *Prepops englemani*. 7. Vesica. 8. Right paramere. 9. Left paramere.

1980. Col: D. Engleman. Deposited in the National Museum of Natural History, Washington, D.C.

*Paratype*. ♀, same date as holotype. Deposited in the collection of the Department of Entomology, Texas A&M University, College Station, Texas.

*Discussion*. *Prepops englemani* is very similar in coloration to *P. turrialbanus* Carvalho & Schaffner. The body length of *P. englemani* is less than 9 mm whereas *P. turrialbanus* specimens exceed 10 mm in length. The aedeagi of the 2 species differ in form.

This species differs from *P. nigricollis* (Reuter), *P. persignandus* (Distant) and *P. rubrovittatus* (Stål) by having a greater amount of lutescent coloration on the anterior portion of the pronotum and also by the structure of the male genitalia.

The species is named in honor of Dr. Dodge Engleman who has generously provided us with material for study.

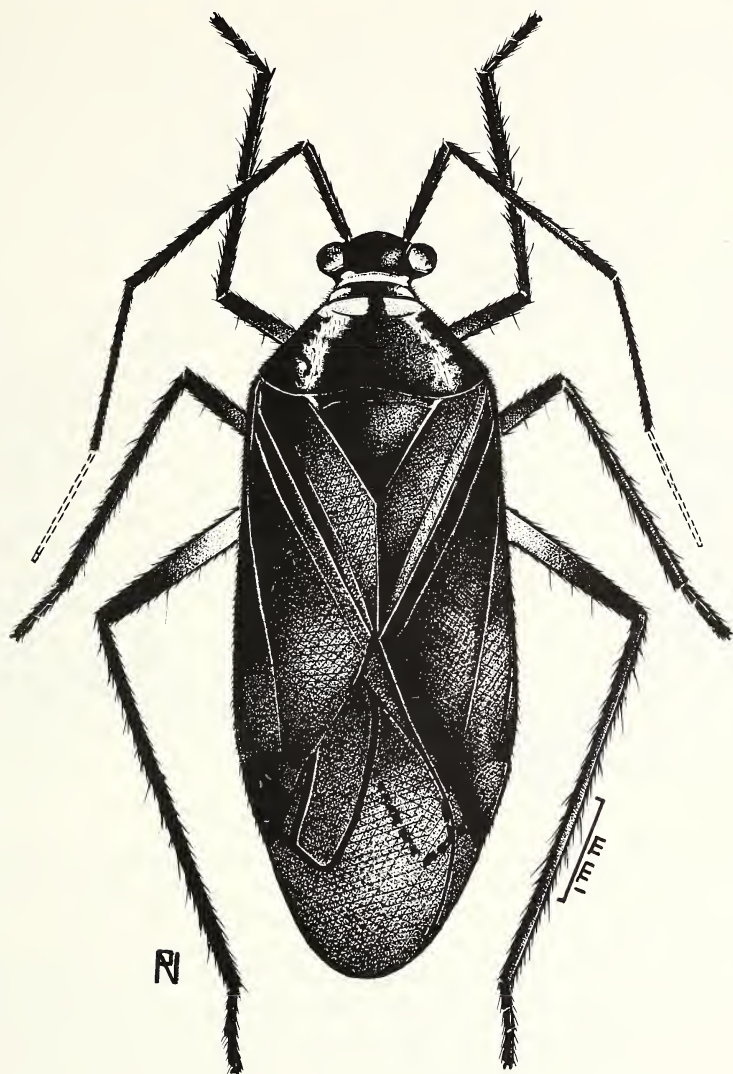
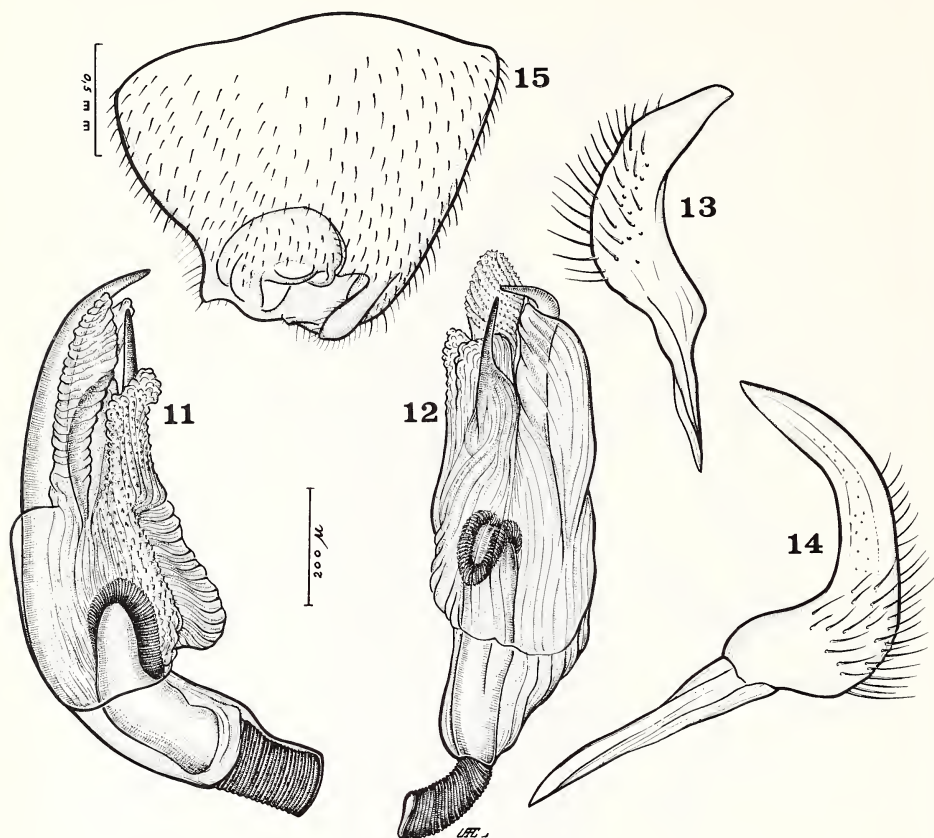


Fig. 10. *Prepops nicaraguensis*, male.

***Prepops nicaraguensis*, new species**

Figs. 10–15

*Description.* Male (holotype). Length, 6.40 mm; width, 2.32 mm. Head length, 0.64 mm; width through eyes, 1.24 mm; vertex width, 0.56 mm. Length of antennal segment I, 0.96 mm; II, 2.00 mm; III, 1.64 mm; IV, 1.20 mm. Pronotal length, 1.20 mm; width, 2.04 mm. Cuneal length, 0.84 mm; width, 0.72 mm.



Figs. 11–15. *Prepops nicaraguensis*. 11, 12. Vesica. 13. Right paramere. 14. Left paramere. 15. Pygophore.

General coloration dark fuscous to black and reddish lutescent; head reddish lutescent with clypeus, vertex except along eyes, lorum and buccula dark fuscous to black; base of antennal segment I pale, remainder of antenna dark fuscous to black; rostrum dark fuscous to black; pronotum reddish lutescent with dorsum of collar, area between calli, broad middorsal area extending to posterior margin and lateral margins fuscous to dark fuscous; mesoscutum black becoming lutescent laterally; scutellum black; hemelytron black; pleural and sternal areas of thorax mainly fuscous with reddish lutescent areas primarily on propleuron and along edge of pleural sclerites; legs with coxae, trochanters and femora light to dark fuscous, tibiae and tarsi black; underside of abdomen lutescent to reddish lutescent with genital capsule light fuscous.

Rostrum reaching mid coxae. Pubescence of body short, fairly dense.

*Genitalia.* Vesica (Figs. 11, 12) with two sclerotized spiculi and membranous lobes;

left paramere (Fig. 14) falciform with numerous dorsal setae; right paramere (Fig. 13) small, curved; pygophore (Fig. 15) with short prong on left upper margin.

Female (paratype). Length, 7.20 mm; width, 2.80 mm. Head length, 0.52 mm; width through eyes, 1.32 mm; vertex width, 0.60 mm. Length of antennal segment I, 1.00 mm; II, 2.20 mm; III, 1.68 mm; IV, 1.28 mm. Pronotal length, 1.40 mm; width, 2.40 mm. Cuneal length, 1.00 mm, width, 0.80 mm.

Similar to male in color and form.

*Holotype*. ♂, NICARAGUA: Esteli, 13.4 mi NW Sebaco, 17 June 1972, CA-3, R. R. & M. E. Murray. Deposited in the National Museum of Natural History, Washington, D.C.

*Paratypes*. 17♂♂, 37♀♀, same data as holotype. Deposited in: the J. C. M. Carvalho collection, Rio de Janeiro, R. J., Brazil; the collection of the Department of Entomology, Texas A&M University, College Station, Texas; and in the collection of the Departamento de Zoologia, Instituto de Biologia, U.N.A.M., Mexico City.

*Discussion*. This is one of several species occurring in the same geographic area having very similar color patterns. It appears to be most similar to *P. latipennis* (Stål) and *P. plenus* (Distant). The pubescence on the dorsal surface of *P. latipennis* specimens is about as long as the diameter of the second antennal segment whereas it is much shorter on individuals of *P. plenus* and *P. nicaraguaensis*. *Prepops nicaraguaensis* specimens have dark fuscous coloration on the humeral corners of the pronotum which usually extends anteriorly along the lateral margin. The middorsal fascia is wide. Although the humeral angles of the pronotum of individuals of *P. plenus* may sometimes be dark fuscous, the coloration seldom continues along the lateral margins of the pronotum. The middorsal pronotal fascia of *P. plenus* is usually not wider than  $\frac{1}{2}$  the width of the pronotum (measured across the base).

### ***Prepops nuevoleonensis*, new species**

Figs. 16–19

*Description*. Male (holotype). Length, 7.84 mm; width, 2.60 mm. Head length, 0.44 mm; width through eyes, 1.28 mm; vertex width, 0.60 mm. Length of antennal segment I, 1.04 mm; II, 2.56 mm; III, 1.36 mm; IV, 1.28 mm. Pronotal length, 1.24 mm; width, 2.04 mm. Cuneal length, 1.08 mm, width, 0.72 mm.

General coloration black and red; head red, clypeus fuscous; antenna black; rostrum dark fuscous to black; pronotum red with edge of humeral angle dark fuscous; mesoscutum red; scutellum red with apex and narrow middorsal line light fuscous; hemelytron black; remainder of thorax and abdomen red; coxae red and faintly fuscous, remainder of legs dark fuscous.

Rostrum reaching hind coxae. Pubescence short, fairly dense, hairs arising from margin of embolium longer than width of embolium. Antennae, femora and tibiae with semierect hairs longer than diameter of parts from which they arise.

*Genitalia*. Vesica (Fig. 17) with membranous lobes, without sclerotized spiculi; left paramere (Fig. 19) falciform, apex terminating in point; right paramere (Fig. 18) small, simple; pygophore without lateral prongs.

Female unknown.



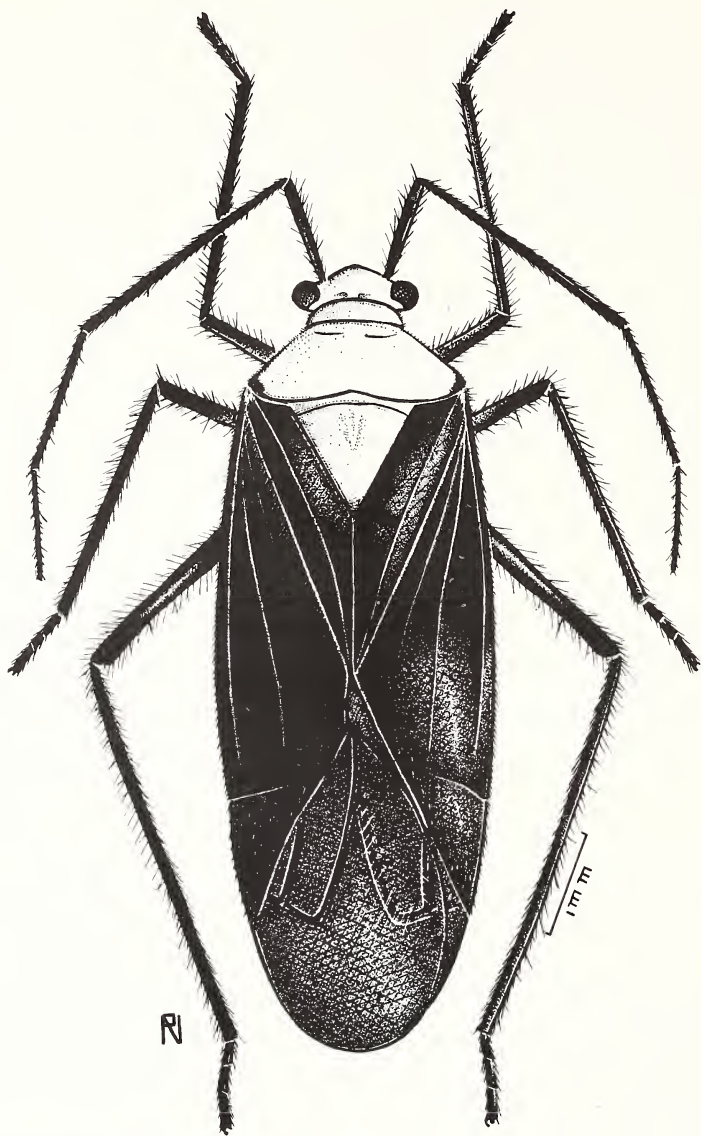
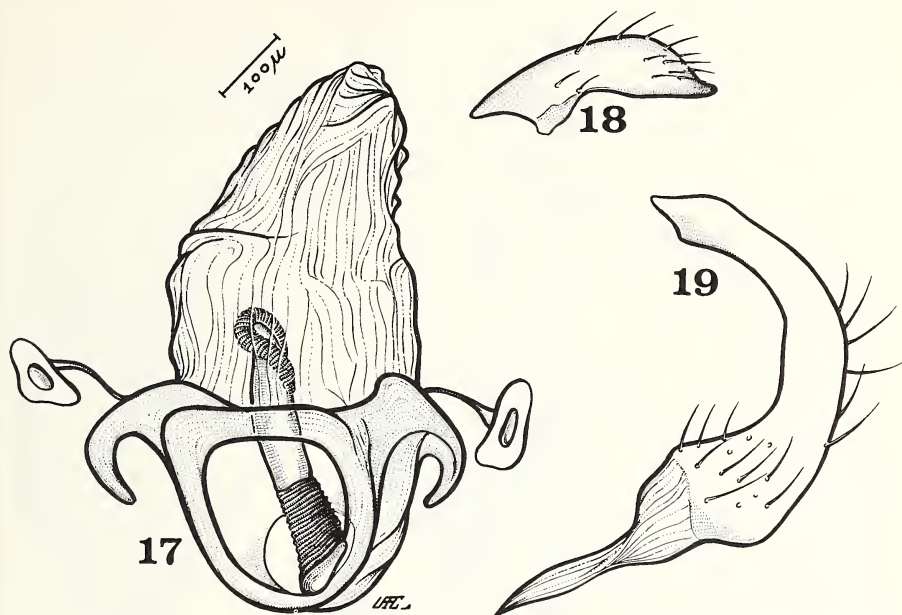


Fig. 16. *Prepops nuevoleonensis*, male.

*Holotype*. ♂, MEXICO: Nuevo Leon, Zaragoza, July 3, 1973, Mastro & Schaffner. Deposited in the National Museum of Natural History, Washington, D.C.

This species is named after the Mexican state in which it was collected.

*Discussion*. *Prepops nuevoleonensis* has a red and black color pattern that is very



Figs. 17–19. *Prepops nuevoleonensis*. 17. Vesica. 18. Right paramere. 19. Left paramere.

similar to that of *P. atripennis* (Reuter). The femora, except for their apices, are red on specimens of *P. atripennis* and entirely black in the case of *P. nuevoleonensis* individuals. The pygophore of *P. nuevoleonensis* lacks lateral prongs whereas the pygophore of *P. atripennis* bears two, one on each side.

#### ***Prepops vittatus*, new species**

Figs. 20–23

*Description.* Male (holotype). Length, 6.80 mm; width, 2.12 mm. Head length, 0.40 mm; width through eyes, 1.20 mm; vertex width, 0.56 mm. Length of antennal segment I, 0.68 mm; II, 2.28 mm; III, 1.16 mm; IV, missing. Pronotal length, 1.24 mm; width, 1.92 mm. Cuneal length, 1.04 mm; width, 0.48 mm.

General coloration black and reddish lutescent to yellowish brown; head reddish lutescent; rostrum lutescent, apex fuscous; antennal segment I and extreme basal area of second segment yellowish brown, remainder of antenna black; pronotum reddish lutescent with small, diffuse fuscous spot behind each callus; mesoscutum and scutellum reddish lutescent; hemelytron yellowish brown with area along claval commissure and area between embolium and radial vein dark fuscous to black, membrane fuscous; coxae reddish lutescent, trochanters, femora and basal areas of tibiae yellowish brown, apices of tibiae and tarsi dark fuscous to black, femora with fuscous spots.

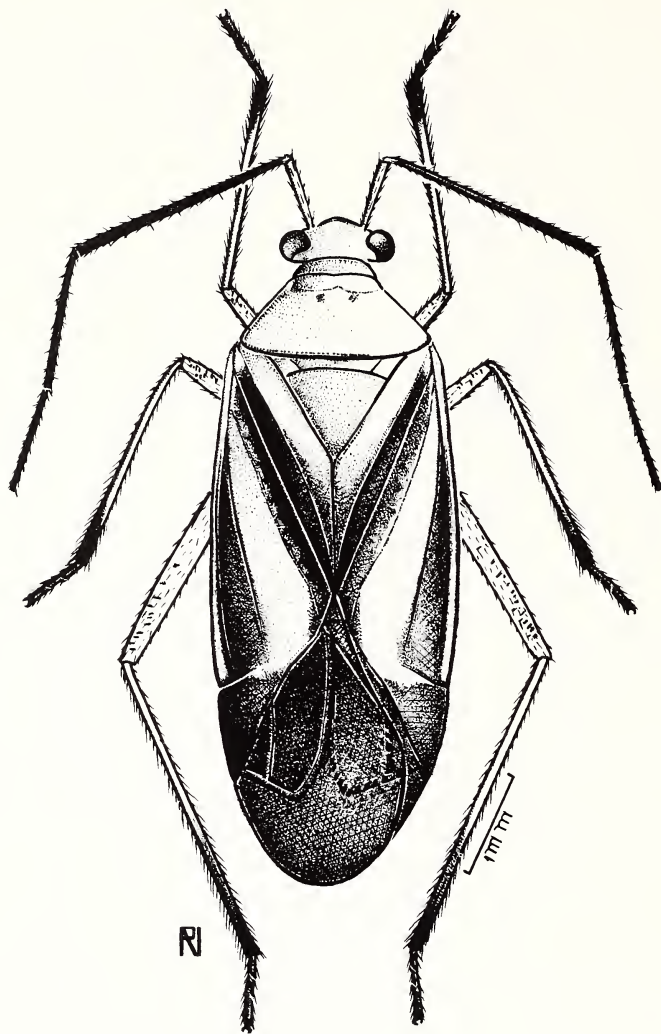


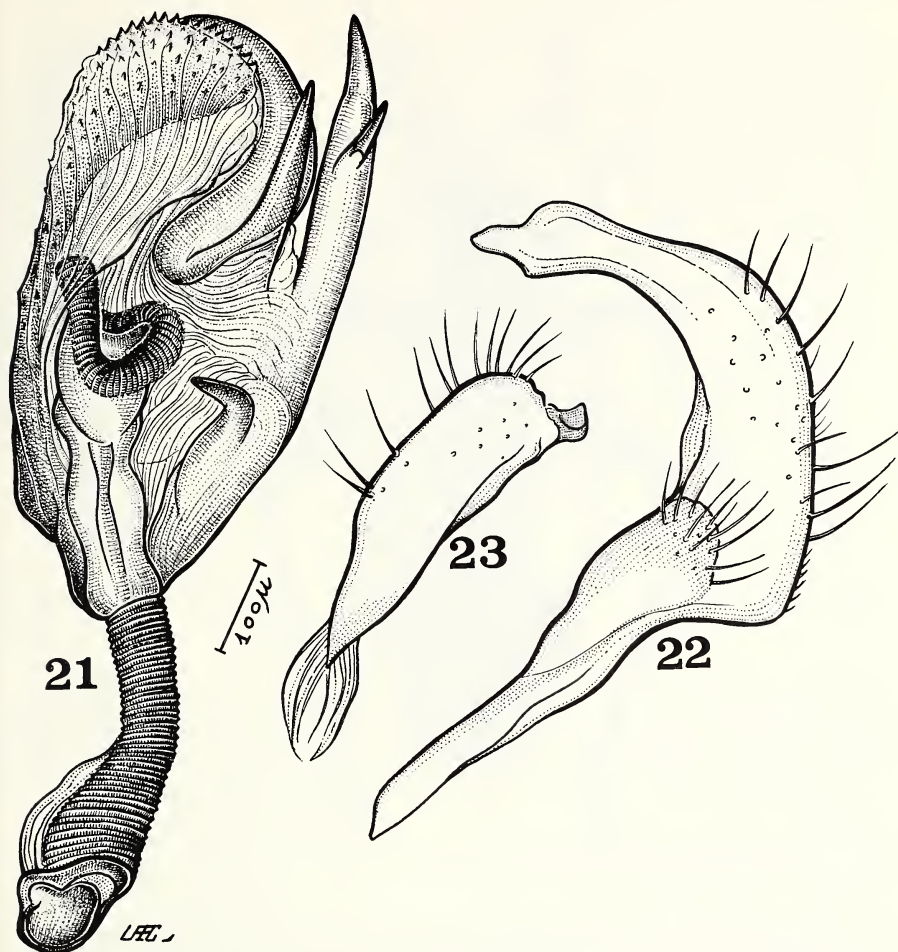
Fig. 20. *Prepops vittatus*, male.

Rostrum reaching apices of mid coxae. Vestiture above extremely short and sparse, head, thorax including scutellum and hemelytron appearing almost glabrous, hairs on abdomen pale, tibiae rather densely covered with fuscous to black hairs.

*Genitalia.* Vesica (Fig. 21) with characteristic sclerotized spiculi; left paramere (Fig. 22) enlarged sub-basally, pointed apically; right paramere (Fig. 23) smaller in size with a blunt sclerotized apex; pygophore without lateral prongs.

Female unknown.

*Holotype.* ♂, MEXICO: Campeche, 31.5 mi N Hopelchen, Aug. 1, 1980, Schaffner,



Figs. 21-23. *Prepops vittatus*. 21. Vesica. 22. Left paramere. 23. Right paramere.

Weaver, Friedlander. Deposited in the National Museum of Natural History, Washington, D.C.

*Discussion.* The color pattern (Fig. 20), especially that of the corium, distinguishes *P. vittatus* from all other known species of the genus.

#### ***Oncerometopus mexicanus*, new species**

Figs. 24-28

*Description.* Male (holotype). Length, 4.80 mm; width, 1.96 mm. Head length, 0.32 mm; width through eyes, 1.04 mm; vertex width, 0.52 mm. Length of antennal



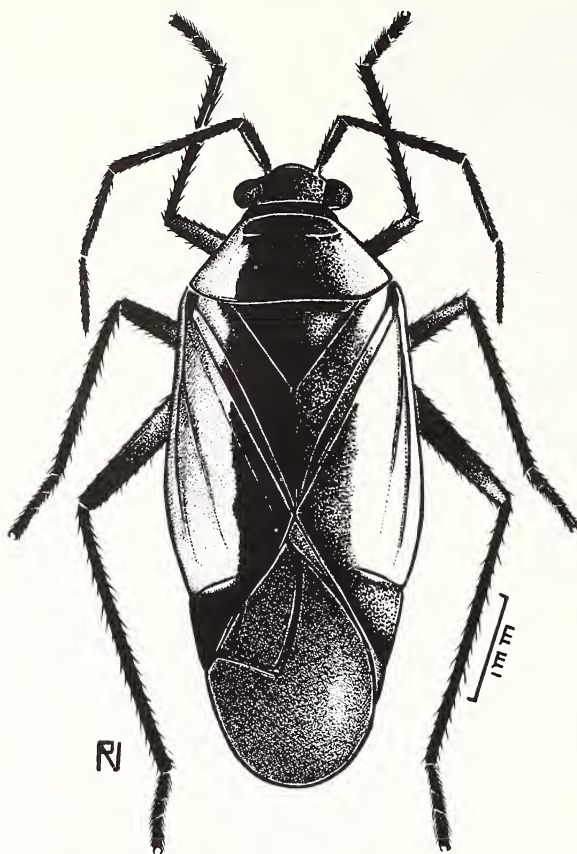


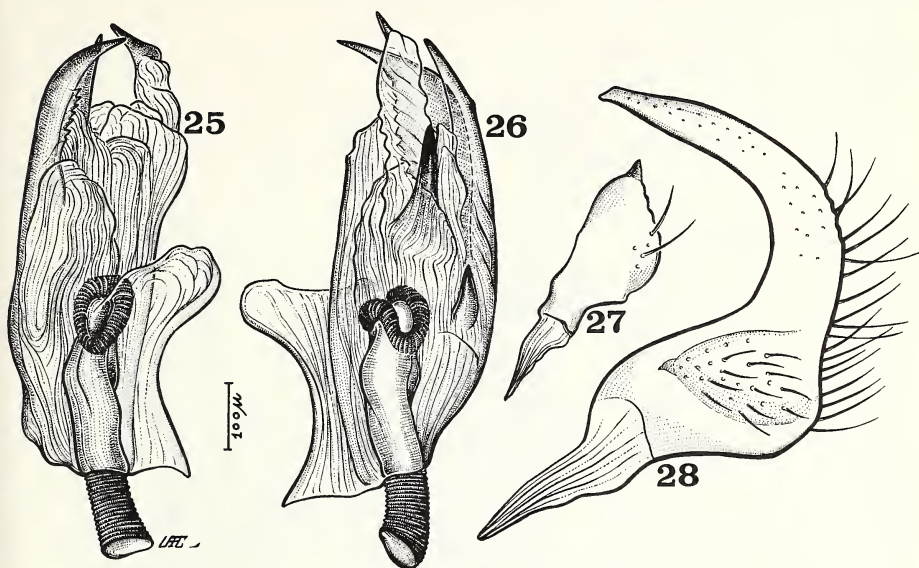
Fig. 24. *Oncerometopus mexicanus*, male.

segment I, 0.40 mm; II, 1.24 mm; III, 0.88 mm; IV, 0.60 mm. Pronotal length, 0.88 mm; width, 1.72 mm. Cuneal length, 0.48 mm; width, 0.68 mm.

General coloration red and fuscous to black; head black with jugum, lorum and gena with reddish cast; rostrum fuscous to black; antenna dark fuscous to black; pronotum red with broad middorsal area fuscous to reddish fuscous; mesoscutum and scutellum dark fuscous to black; hemelytron red with apical region of embolium and restricted area at base of wing fuscous, apical  $\frac{2}{3}$  of clavus and adjacent part of corium extending apically parallel with hemelytral commissure and continuing along margin of membrane fuscous, cuneus black; remainder of thorax reddish fuscous to black; legs dark fuscous to black; abdomen reddish becoming fuscous posteriorly.

Rostrum reaching or surpassing hind coxae. Pubescence of head, thorax including scutellum and hemelytron scattered, short, appearing almost glabrous.

*Genitalia.* Vesica (Figs. 25, 26) with five sclerotized spiculi; left paramere (Fig. 28) enlarged sub-basally, falciform, with long dorsal setae; right paramere (Fig. 27) somewhat globose, apex pointed.



Figs. 25–28. *Oncerometopus mexicanus*. 25, 26. Vesica. 27. Right paramere. 28. Left paramere.

Female (paratype). Length, 5.60 mm; width, 2.28 mm. Head length, 0.40 mm; width through eyes, 1.16 mm; vertex width, 0.60 mm. Length of antennal segment I, 0.40 mm; II, 1.24 mm; III, 0.84; IV, missing. Pronotal length, 1.08 mm; width, 1.84 mm. Cuneal length, 0.76 mm; width, 0.56 mm.

Similar to male in color and form.

*Holotype*. ♂, MEXICO: Zacatecas, 28 miles northeast Sierra Viejo, April 17, 1977, El. 6,600'; Murray, Schaffner, Sweet. Deposited in the National Museum of Natural History, Washington, D.C.

*Paratypes*. ♀, MEXICO: Mexico, 9.7 miles north of San Jeronimo, July 26, 1976, Piegler, Gruetzmacher, R & M Murray, Schaffner; ♂, Coahuila, 15 mi S Saltillo, July 8, 1983, Kovarik, Harrison, Schaffner. Deposited in the collection of the Department of Entomology, Texas A&M University, College Station, Texas.

Differs from *O. impictus* Knight by the color of the pronotum and by the structure of the male genitalia.

### ***Platytylus binotatus*, new species**

Figs. 29–32

*Description*. Male (holotype). Length, 12.20 mm; width, 4.20 mm. Head length, 0.80 mm; width through eyes, 1.88 mm; vertex width 1.00 mm. Length of antennal segment I, 1.40 mm; II, 3.20 mm; III, 2.40 mm; IV, 0.92 mm. Pronotal length, 2.04 mm; width, 3.28 mm. Cuneal length, 1.84 mm; width, 1.00 mm.

General coloration black and lutescent; head, basal rostral segment and base and apex of second rostral segment lutescent, remainder of rostrum and antennae dark



Fig. 29. *Platytylus binotatus*, male.

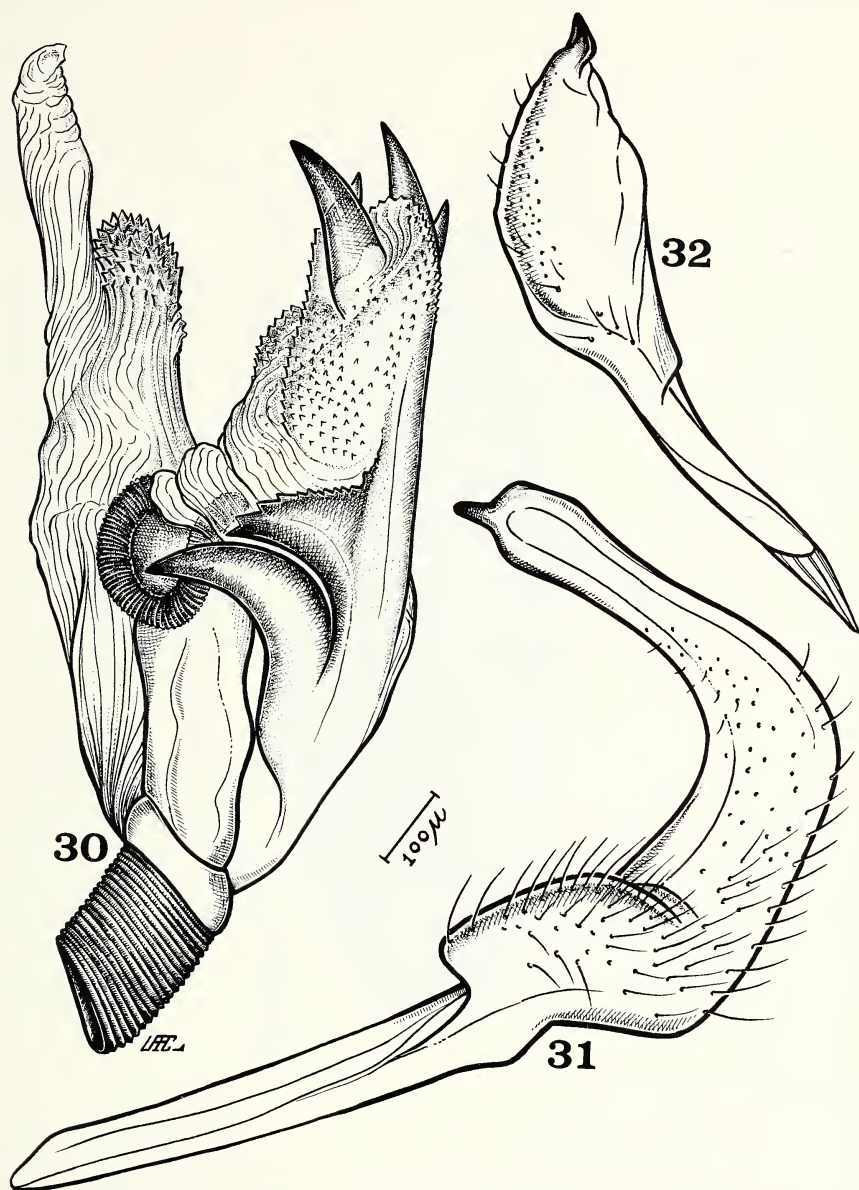
fuscous to black; prothorax lutescent with calli and area immediately adjacent posteriorly dark fuscous; mesoscutum fuscous becoming lutescent laterally; scutellum and hemelytron black; remainder of thorax lutescent; coxae lutescent, remainder of legs dark fuscous to black; abdomen lutescent.

Rostrum reaching mid coxae. Body shining and glabrous as seen from above with very short hairs visible on cuneus and edge of embolium; hairs on underside short, more dense on abdomen.

*Genitalia.* Vesica (Fig. 30) with several sclerotized spiculi and membranous lobes bearing minute teeth; left paramere (Fig. 31) curved, thicker at base; right paramere (Fig. 32) smaller tapering apically.

Female (paratype). Length, 12.04 mm; width, 4.28 mm. Head length, 0.92 mm; width through eyes, 1.92 mm; vertex width, 1.08 mm. Length of antennal segment I, 1.40 mm; II, 2.88 mm; III, 2.44 mm; IV, 0.96 mm. Pronotal length, 2.16 mm; width, 3.48 mm. Cuneal length, 1.72 mm; width, 1.04 mm.

Similar to male in color and form.



Figs. 30–32. *Platytylus binotatus*. 30. Vesica. 31. Left paramere. 32. Right paramere.



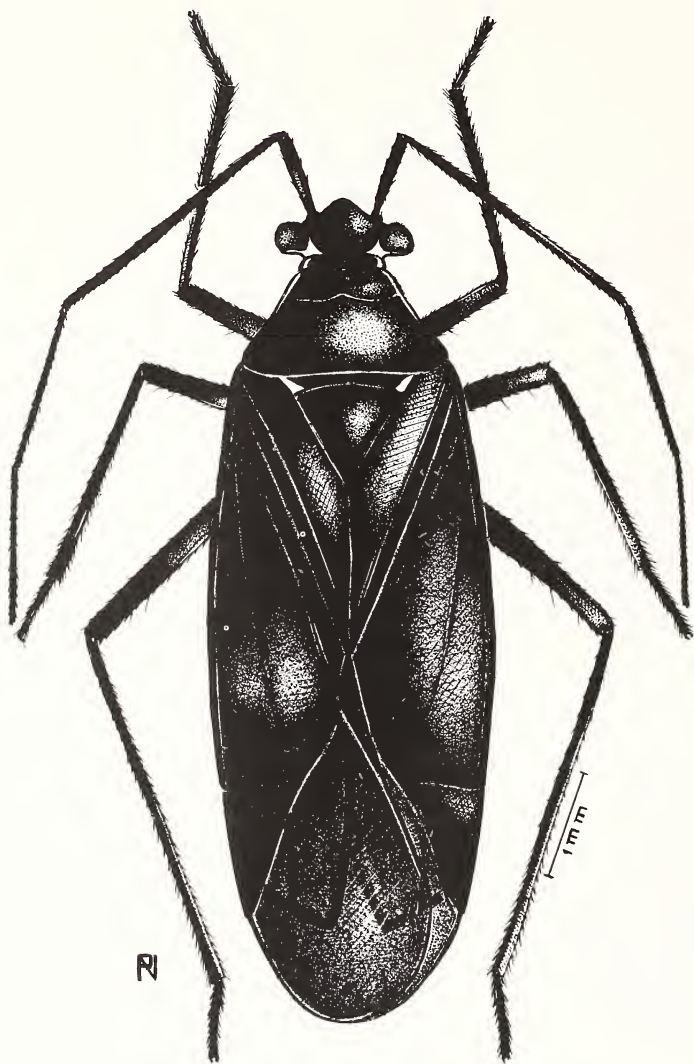


Fig. 33. *Platytylus rubriventris*, male.

*Holotype*. ♂, MEXICO: Jalisco, 16 km N Autlan, July 31–Aug. 2, 1978. Deposited in the National Museum of Natural History, Washington, D.C.

*Paratypes*. 1♀, 6♂♂, same data as holotype; 3♂♂, ♀, same data except July 12–14, 1983, Kovarik, Harrison, Schaffner. Deposited in the J. C. M. Carvalho collection, Rio de Janeiro, R. J., Brazil, the collection of the Department of Entomology, Texas A&M University, College Station, Texas and in the collection of the Instituto de Biologia U.N.A.M., Mexico City, Mexico.

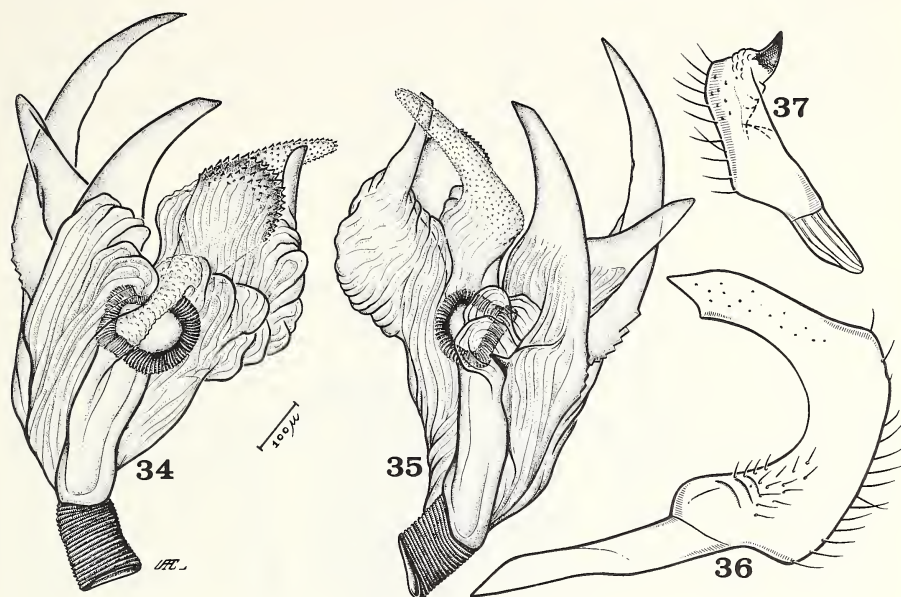


Fig. 34–37. *Platytylus rubriventris*. 34, 35. Vesica. 36. Left paramere. 37. Right paramere.

**Discussion.** In the key to the species of the genus (Carvalho & Schaffner, 1975), this species exits at the last couplet. It resembles *P. bisignatus* Carvalho & Schaffner in that both have 2 fuscous markings or spots on the pronotum, however, those of *P. bisignatus* touch the posterior margin of the pronotum whereas those of *P. binotatus* do not. *Platytylus binotatus* has a black scutellum and *P. bisignatus* has an orange lutescent one. There are other color differences as well as differences in the genitalia. *Platytylus binotatus* most closely resembles *P. notatus* Carvalho & Schaffner. The major difference in coloration is one large single spot on the pronotum in the case of *P. notatus* and two spots on the pronotum of *P. binotatus*. There are also differences between the aedeagi of the two forms.

#### ***Platytylus rubriventris*, new species**

Figs. 33–37

**Description.** Male (holotype). Length, 7.84 mm; width, 2.80 mm. Head length, 0.60 mm; width through eyes, 0.60 mm; vertex width, 1.52 mm. Length of antennal segment I, 0.80 mm; II, 2.80 mm; III, 1.60 mm; IV, 1.36 mm. Pronotal length, 1.32 mm; width, 2.08 mm. Cuneal length, 1.24 mm; width, 0.80 mm.

General coloration black and red; head with vertex, frons and clypeus fuscous to black, remainder red; antennae and rostrum black; pronotum black above, red on sides; mesoscutum black, red at lateral corners; scutellum and hemelytron black; pleural and sternal regions of thorax red; legs fuscous to black; abdomen red except for small fuscous area on venter of pygophore.

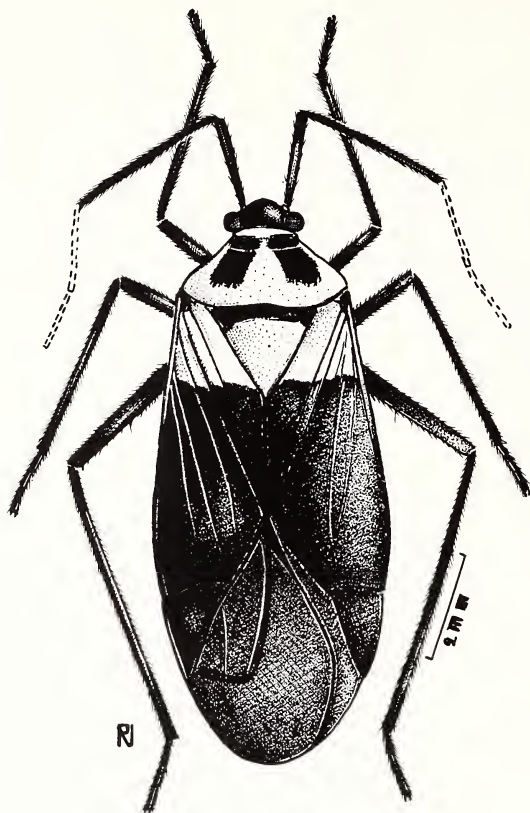


Fig. 38. *Platytylus veracruzensis*, female.

Rostrum reaching mid coxae. Lateral margins of pronotum rounded, carinate over procoxal cleft. Hemelytron, except for membrane, minutely granulate. Vestiture consisting of short sparsely set hairs above, hairs below slightly longer and more dense.

*Genitalia.* Vesica (Figs. 34, 35) with 4 spiculi and membranous lobes, 2 with minute teeth; left paramere (Fig. 36) curved, thickened at base, pointed at apex; right paramere (Fig. 37) smaller, curved at apex.

Female (paratype). Length, 8.40 mm; width, 3.20 mm. Head length, 0.68 mm; width through eyes, 1.60 mm; vertex width, 0.80 mm. Length of antennal segment I, 0.92 mm; II, 2.64 mm; III, 1.60 mm; IV, missing. Pronotal length, 1.40 mm; width, 2.32 mm. Cuneal length, 1.28 mm; width, 0.84 mm.

Similar to male in color and form.

*Holotype.* ♂, MEXICO: Oaxaca, 2.1 mi NW Totolapan, July 11–17, 1981, Bogar, Schaffner, Friedlander. Deposited in the National Museum of Natural History, Washington, D.C.

*Paratype.* ♀, same data as holotype. Deposited in the collection of the Department of Entomology, Texas A&M University, College Station, Texas.

*Discussion.* This distinctive species differs from other members of the genus by the minutely granulate nature of the embolium, corium, clavus and cuneus as well as by the coloration. In the key to members of this genus (Carvalho and Schaffner, 1975), *P. rubriventris* keys to the last couplet but clearly does not fit either of the choices.

***Platytylus veracruzensis*, new species**

Figs. 38

*Description.* Female (holotype). Length, 11.20 mm; width, 4.32 mm. Head length, 0.80 mm; width through eyes, 1.68 mm; vertex width, 0.72 mm. Length of antennal segment I, 1.76 mm; II, 3.16 mm; III, 2.32 mm; IV, missing. Pronotal length, 2.04 mm; width, 3.40 mm. Cuneal length, 1.76 mm; width, 0.96 mm.

General coloration black and reddish lutescent; head black with margin of lorum and anterior margin of buccula brown; antennae and rostrum dark brown to fuscous; prothorax reddish lutescent, pronotum with 2 dark fuscous, somewhat irregular fasciae each extending from anterior part of callus posteriorly towards, but not reaching, posterior margin of pronotum, fasciae running parallel to lateral margin thus diverging from one another posteriorly, mesoscutum black, faintly lutescent on middorsal line; scutellum reddish lutescent; mesepisternum and mesosternum primarily black, remainder of thorax reddish lutescent; hemelytron black with basal  $\frac{2}{5}$  of embolium, basal  $\frac{1}{5}$  of wing reddish lutescent; coxae, basal half of trochanters reddish lutescent, remainder of legs dark fuscous to black; abdomen black.

Rostrum reaching posterior trochanters. Pubescence short and inconspicuous, appearing glabrous above. Second antennal segment somewhat incrassate medially. Pronotum carinate only above procoxa.

Male unknown.

*Holotype.* ♀, San Rafael, Jicaltepec, Vera Cruz, June 96. Deposited in the J. C. M. Carvalho collection, Rio de Janeiro, R. J., Brazil.

*Paratype.* ♀, same data as holotype. Deposited in the collection of the Department of Entomology, Texas A&M University, College Station, Texas.

The species is named after the Mexican state in which it was collected.

*Discussion.* This species keys to couplet 8 in the key to the species of *Platytylus* (Carvalho & Schaffner, 1975). The color pattern appears most similar to *P. chiriquinus* (Distant) because of the black head and mesoscutum. *Platytylus veracruzensis* differs, however, by having the dark fuscous fasciae on the pronotum covering and extending posteriorly from each of the calli.

ACKNOWLEDGMENTS

Illustrations were prepared by Luiz Antonia Alves Costa and Paulo Roberto Nascimento under the direction of the senior author. Appreciation is also extended to Dr. H. R. Burke for his critical review of this manuscript.

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## ***ORTHOTYLUS AESCULICOLA*: A NEW PLANT BUG FROM MISSOURI (HETEROPTERA: MIRIDAE: ORTHOTYLINAE)**

R. L. BLINN

Department of Entomology, University of Missouri,  
Columbia, Missouri 65211

**Abstract.**—*Orthotylus aesculicola* is described as new from Missouri. This mirid was found breeding on Ohio buckeye, *Aesculus glabra* Willd. (Hippocastanaceae). The adult male and genitalia of the male and female are illustrated.

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The genus *Orthotylus* is a large group, with more than 100 species world-wide and 45 North American species listed in Carvalho's (1958) Catalog. Henry (1979) described 3 new species from the United States. In addition, a number of Palearctic species have been recognized for North America: *O. concolor* (Kirschbaum) from Massachusetts (Knight, 1922), *O. nassatus* (Fab.) from Pennsylvania (Henry, 1977), and *O. viridineris* (Kirschbaum) from Ontario, Canada (Henry and Wheeler, 1979).

In this paper a new species of *Orthotylus* is described to provide a name to be used in a forthcoming paper on the life history of the plant bug fauna associated with *Aesculus glabra* Willd.

The following abbreviations are for institutions and collections cited in this paper: AMNH, American Museum of Natural History, New York; EMUM, Wilbur R. Enns Entomology Museum, University of Missouri–Columbia; RLB, Robert L. Blinn collection; TAM, Texas A&M University, College Station; USNM, U.S. National Museum of Natural History, Washington, D.C. All measurements are in millimeters.

### ***Orthotylus aesculicola*, new species**

Figs. 1–7

**Diagnosis.** The general black color, with contrasting yellowish green to pale green lateral margins of the pronotum and hemelytra, and the male parameres will separate *aesculicola* from all other North American *Orthotylus*.

**Description.** Holotype male: Length 4.90–5.10, width 1.30–1.40, generally black with lateral margins of pronotum and hemelytra yellowish orange to pale green, dorsum with recumbent pale setae.

Head: Length 0.38–0.43, width 0.76–0.80, vertex 0.35–0.38, shiny black with lora, gena, antennal fossae and narrow area bordering eyes yellowish orange. Rostrum: Length 1.15–1.33, attaining mesocoxae, pale green, apex darkened. Antennae: Black; I, length 0.44–0.50; II, 1.55–1.75; III, 0.85–0.93; IV, 0.49–0.58.

Pronotum: Length 0.63–0.68, humeral width 1.06–1.21, yellowish orange, posterior margins of calli (some paratypes with entire calli), area between calli and rays posterior of calli extending to basal margin black; propleura shiny black, ventral margin and xyphus pale green; mesoscutum black, lateral margins appearing paler; scutellum

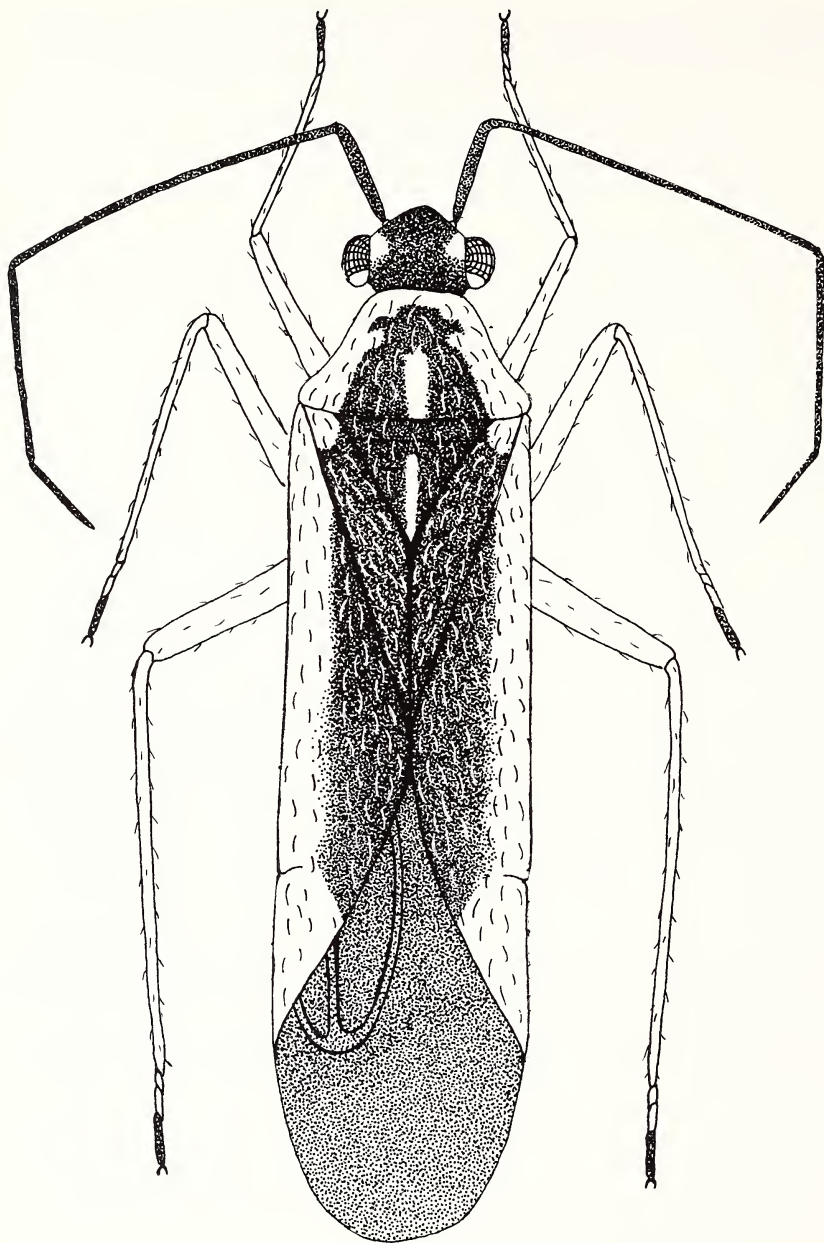
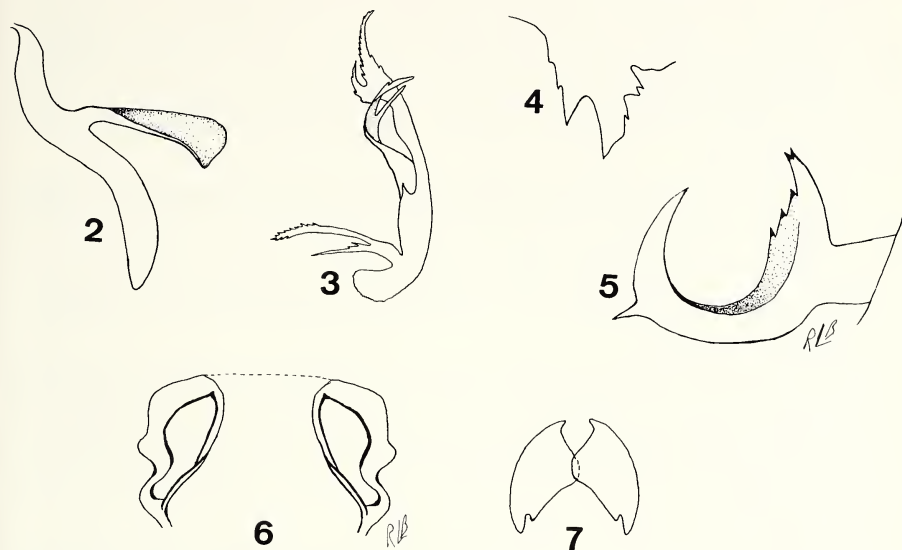


Fig. 1. *Orthotylus aesculicola*, male habitus.



Figs. 2-7. *Orthotylus aesculicola*. 2-5. Male genitalia. 2. Left paramere, dorsal-lateral view. 3. Spiculum. 4. Tergal process. 5. Right paramere, dorsal lateral view. 6, 7. Female genitalia. 6. Posterior view of sclerotized rings. 7. Posterior view of posterior wall.

rugulose, black, with yellowish green median line (some paratypes lacking pale median line).

Hemelytra: Black, lateral margins yellowish orange basally, distinctly pale green on apical  $\frac{2}{3}$ ; cuneus pale green with inner margin infuscated; membrane and veins translucent infuscate. Mesosternum yellowish orange with dorsal lateral area black; metasternum black, scent gland peritreme pale green; abdomen yellowish orange to brown, dorsal lateral margin shiny black. Legs pale green, spines light brown; tarsi dusky, 3rd tarsal segments and claws brown.

Genitalia: Right paramere C-shaped, distal arm acute with perpendicular median spinous process; proximal arm bifurcate with several short median spines along inner edge (Fig. 5). Left paramere deeply bifurcate, similar to that of other species of genus (Fig. 2). Spiculum (Fig. 3). Small tergal process on posterior margin of genital aperture left of the median line (Fig. 4).

Female: Similar to male in color and pubescence; dark areas less extensive. Length,  $N = 9$ , 4.70-5.30, width 1.20-1.48. Head: Length 0.41-0.46, width 0.76-0.81, vertex 0.39-0.43. Rostrum 1.28-1.38. Antennae: I, length 0.45-0.50; II, 1.63-1.78; III, 0.88-0.98,  $N = 7$ ; IV, 0.51-0.58,  $N = 7$ . Pronotum: Length 0.64-0.70, humeral width 1.11-1.21. Genitalia: Sclerotized rings (Fig. 6); posterior wall (Fig. 7).

*Holotype*. ♂: Missouri, Boone Co., Columbia, May 17, 1985, R. L. Blinn coll., taken on *Aesculus glabra* (USNM).

*Allotype*. ♀: same data as for holotype, May 30, 1985 (USNM).



*Paratypes.* Same data as for holotype: 1♂, May 23, 1984 (EMUM); 1♂, May 24, 1984 (EMUM); 1♀, June 11, 1984 (EMUM); 1♀, May 3, 1985 (AMNH); 1♀, May 7, 1985 (TAM); 1♂, May 17, 1985 (AMNH); 1♂, 3♀♀, May 21, 1985 (RLB, EMUM); 5♂♂, 3♀♀, May 25, 1985 (EMUM); 2♂♂, June 1, 1985 (EMUM, TAM).

*Etymology.* The specific epithet *aesculicola* refers to the host plant, *Aesculus glabra* (Hippocastanaceae).

*Remarks.* *Orthotylus aesculicola* is the only species of the genus known to breed on *A. glabra* in North America; this early-season, univoltine species is the second plant bug known only from Missouri that breeds exclusively on *A. glabra*, the other being *Lygocoris aesculi* (Knight, 1953). Additional collecting early in the season in other states where *A. glabra* grows will undoubtedly increase the known range of *O. aesculicola* and *L. aesculi*.

*Orthotylus aesculicola* appears closely related to *O. affinis* Van Duzee (1916) based on the similarity of the right parameres. *Orthotylus aesculicola* is recognized by the black antennal segments, the nearly black head, and smaller size. In *affinis*, the antennal segments are pale and the head is pale with the black areas reduced to two triangular marks on the vertex, two arcuate marks on the frons, and a spot at the base of the clypeus.

*Orthotylus aesculicola* keys to *dorsalis* (Provancher) in Knight (1923, 1941) and Blatchley (1926); however, the color pattern and genital parameres of *aesculicola* will easily distinguish it from *dorsalis*.

#### ACKNOWLEDGMENTS

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## TWO NEW GENERA AND SPECIES OF PENTATOMINI FROM PERU AND BRAZIL (HEMIPTERA: PENTATOMIDAE)

L. H. ROLSTON

Department of Entomology, Louisiana Agricultural Experiment Station,  
Louisiana State University Agricultural Center,  
Baton Rouge, Louisiana 70803

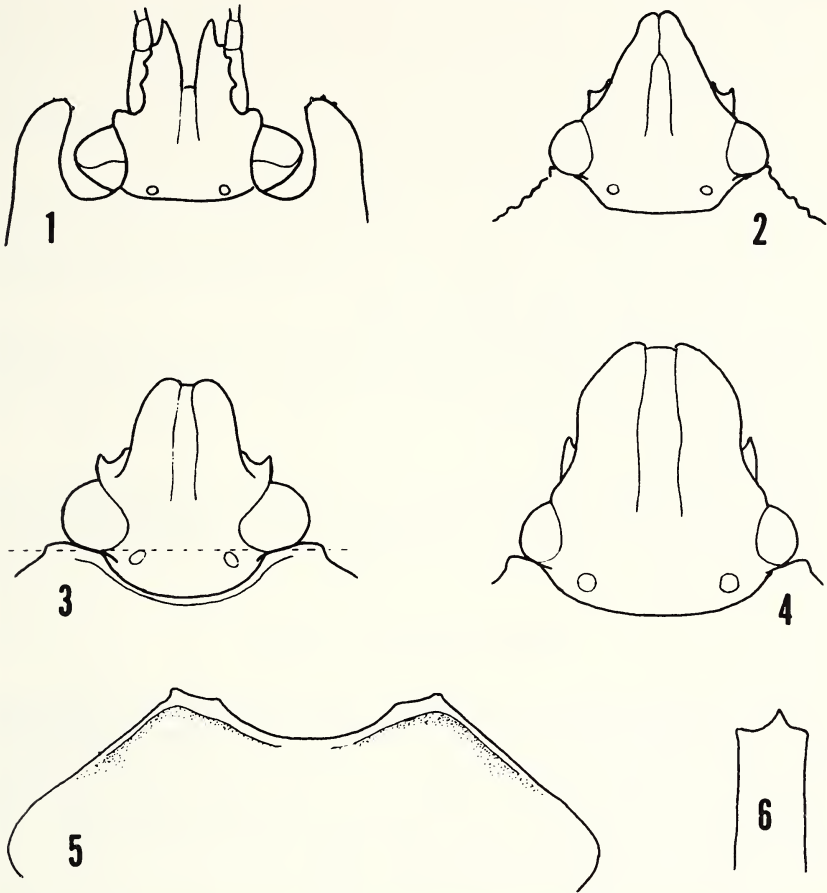
*Abstract.*—Two new monotypic genera, each based on a new species, are described from eastern Peru and western Brazil. These genera are among those of the Pentatomini tribe that do not have a median spine or tubercle at the base of the abdominal venter, and among the few South American genera of this group with much elongated ostiolar rugae. A key to these genera is provided.

Among the genera of Pentatomini that do not have a basal spine or tubercle on the abdominal venter, there are seven occurring in South America that have markedly elongated ostiolar rugae. In these genera the length of the ostiolar ruga on each side is  $\frac{3}{5}$  or more of the distance from the mesial margin of the ostiole to the lateral margin of the metapleuron. Only one other South American genus among the genera of Pentatomini lacking a basal spine or tubercle on the abdominal venter has ostiolar rugae approaching this length. This genus, the monotypic *Cauracia* Stål, can hardly be confused with any other (Fig. 1).

The seven genera in question do not form a phylogenetic group, but their much elongated ostiolar rugae distinguish them among more than half a hundred genera of Pentatomini in South America. The following key separates the seven genera. Two of these genera are new, each monotypic and each based on a new species.

### KEY TO GENERA

1. Jugal process surpassing tylus, contiguous apically or leaving deep incision or emargination in apex of head (Figs. 2, 7) ..... 2
- Jugal process no longer than tylus, or only slightly longer and either rounded apically or leaving shallow, quadrate emargination in apex of head (Figs. 3, 4, 13) ..... 3
- 2(1). Metasternum obtusely produced with anterior, posterior and lateral buttresses (Fig. 9); apex of rostrum passing procoxae but not reaching mesocoxae; superior surface of femora unarmed apically ..... *Patanius*, new genus
- Metasternum nearly flat; apex of rostrum between or projecting beyond metacoxae; superior surface of femora projecting apically as small tooth (Fig. 6) . *Chloropepla* Stål
- 3(1). Femora armed on inferior surface with pairs of small tubercles (Fig. 15); imaginary line traversing head at posterior limit of reticulated portion of both eyes passing through ocelli when dorsum of head horizontal (Fig. 13) ..... *Senectius*, new genus
- Femora unarmed; ocelli behind or just touching such imaginary line (Fig. 3) ..... 4
- 4(3). Rostrum projecting past abdominal apex; length of head before eyes about  $\frac{1}{10}$  of greatest width before eyes ..... *Brasilania* Jensen-Haarup
- Rostrum reaching no farther than fifth visible sternite; length of head before eyes  $\frac{1}{10}$  or less of greatest width before eyes ..... 5



Figs. 1-6. 1. *Cauracia sexdens* Stål, head and anterolateral pronotal angles. 2. *Chloropepla vigens* (Stål), head. 3. *Arocera spectabilis* (Drury), head. 4. *Cyptocephala cogitabunda* Berg, head. 5. *Arocera spectabilis* (Drury), anterior and anterolateral pronotal margins. 6. *Chloropepla vigens* (Stål), superior surface of femur distally.

- 5(4). Anterolateral margins of pronotum reflexed or rimmed, especially at anterolateral angles (Fig. 5); 12 mm or more in length or if smaller then yellow to red with conspicuous dark markings ..... *Arocera* Spinola
- Anterolateral margins of pronotum weakly reflexed at most; less than 12 mm in length ..... 6
- 6(5). Parameres bilobed, finely denticulate between lobes ..... *Cyptocephala* Berg
- Parameres acute or subacute apically, without denticles ..... *Thyanta* Stål

**Patanius, new genus**

*Type species. Patanius vittatus*, new species.

*Diagnosis.* Jugal contiguous before tylus, broadly so or dehiscent, their lateral mar-



gins concave before anteocular projection. Interocular width about  $\frac{3}{5}$  width of head across eyes. Imaginary line traversing head at posterior limit of reticulated part of both eyes passing before ocelli when dorsum of head horizontal (Fig. 7). Antennae 4-segmented, basal segment projecting past apex of head. Each buccula a large lobe directed anteroventrad (Fig. 8). Basal segment of rostrum projecting beyond bucculae; rostral apex reaching beyond procoxae but not attaining mesocoxae.

Scutellum about  $\frac{1}{3}$  longer than wide at base; width at distal end of frena about  $\frac{3}{10}$  of basal width. Costal angle of each corium reaching last tergite before genitalia.

Anterior margin of propleura not produced. Ostiolar ruga on each side extending about  $\frac{7}{10}$  distance from mesial margin of ostiole to lateral margin of metapleuron. Femora unarmed; tibiae weakly sulcate dorsally.

Prosternum nearly flat. Mesosternum somewhat tumid, scarcely carinate mesially. Metasternum obtusely produced with buttress anteriorly, posteriorly and laterally between each mesocoxa and metacoxae (Fig. 9). Base of abdomen without mesial spine or tubercle.

Parameres absent.

*Remarks.* The absence of parameres is rare among pentatomoids, but among American pentatomines this characteristic is shared with an unnamed genus and with *Rhyncholepta* Bergroth, a genus containing two very similar species (Becker and Grazia-Vieira, 1971).

#### *Patanius vittatus*, new species

Figs. 7-12

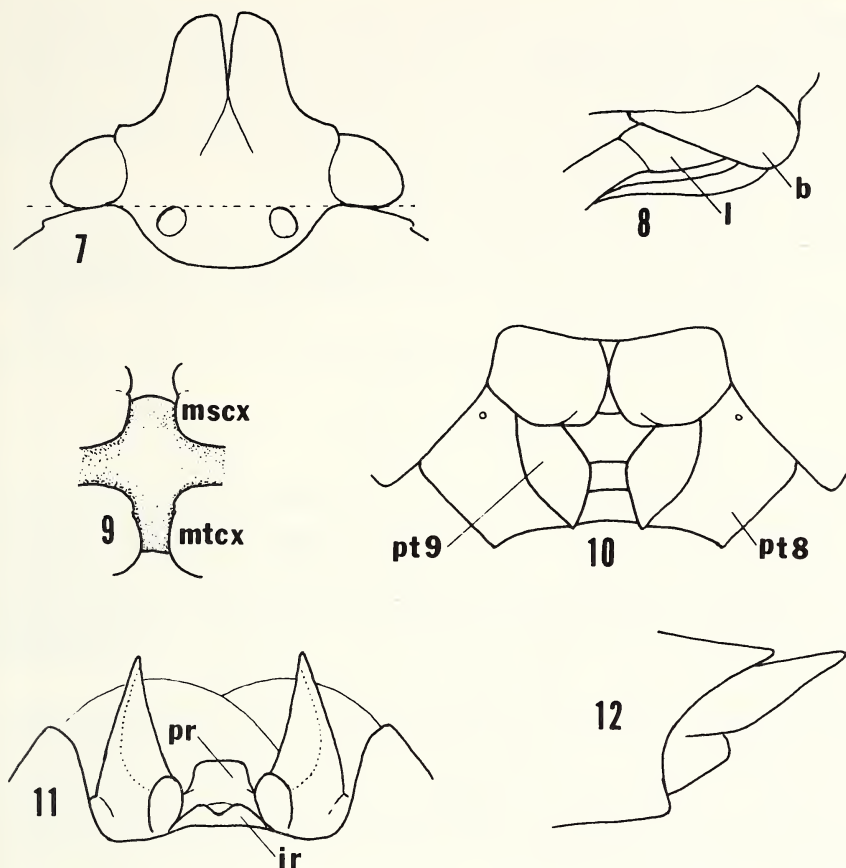
*Description.* Predominately green with light yellow markings most evident as dorsal stripes; colors deteriorate to olive green and rusty yellow. Body length excluding hemelytral membranes about 10.5 mm.

Lateral margins of juga, tylus, and sometimes vertex yellow. Lateral jugal margins strongly concave before obtuse anteocular process. Vertex convex. Width of head across eyes 2.05-2.2 mm, length from ocelli to apex 1.2-1.25 mm; interocular width 1.2-1.3 mm; distance across ocelli 0.8-0.9 mm. Ocelli rather large, 0.2 mm at greatest diameter. Antennal segments 1-4 about 0.6-0.65, 2.4-2.7, 1.8-2.1, 2.1-2.25 mm long; basal segment green, remaining segments light brown.

Pronotum with anterolateral margins and three intramarginal transverse bands yellow, calloused or subcalloused, impunctate or nearly so; two of these bands on anterior disk, separated by depression. Anterolateral margins straight; humeri projecting a little laterad beyond base of hemelytra, narrowly rounded. Width of pronotum at humeri 5.4-5.5 mm; mesial length 2.3-2.4 mm.

Yellow markings on scutellum consisting of: basal, calloused, caudally curved band connecting basal angles; subbasal chevron beginning submarginally on each side, pointing toward scutellar apex; thin mesial line connecting basal band and apex of chevron, continuing as broader band to scutellar apex; lateral scutellar margins from level of chevron to distal ends of frena.

Each corium marked by four yellow bands, one basally on clavus, three on endocorium as follows: one along clavical suture, one beginning about basal third of corium at R+M vein and curving across disk, one along distal third of R+M vein. Corial margins joining membranes subparallel; costal angle of each corium rounded.



Figs. 7–12. *Pataninus vittatus*. 7. Head. 8. Bucculae and basal segment of labium (b, buccula; l, labium). 9. Metasternum (mscx, mesocoxa; mtcx, metacoxa). 10. Genital plates (pt 8, paratergite 8; pt 9, paratergite 9). 11. Pygophore, ventral view (ir, inferior ridge; pr, proctiger). 12. Pygophore, lateral view.

Membranes hyaline, each with fumose streak near corium and four or five simple veins.

Connexiva yellow to orange, their transverse sutures bordered on both sides with green to black band. Posterolateral angle of each segment projecting slightly, acute.

Venter green, mottled with yellow, impunctate. Lateral margins of abdominal venter edged in black on both sides of sutures between sternites.

Posterior margin of each basal plate broadly rounded; apex of 9th paratergite acute, of 8th paratergite right-angular (Fig. 10). Spiracle present on 8th paratergite.

Posterolateral corners of pygophore acuminate, projecting well beyond last tergite before genitalia, their mesoventral surface concave, firmly attached to remainder of pygophore but largely separated in partially cleared pygophore by apparent, unpigmented suture (Fig. 11); pair of large, subparallel, obtuse ridges flanking ventral

emargination of pygophore (Fig. 12). Inferior ridge almost membranous, nearly horizontal, mesially emarginate, largely closing ventral opening of proctiger distally. Proctiger without tubercles. Theca heavily pigmented, arcuate from lateral view, lacking lobes or appendages distally; median penial lobes joined at base ventrally, forming trough; penisfilum sigmoid, not projecting beyond median penial lobes; single conjunctival diverticulum dorsomedial, cylindrical, hyaline.

*Distribution.* Brazil (Rondônia, Mato Grosso).

*Holotype.* ♂ labeled "Brésil, Rondônia" (white label pasted on purple label), "Coll. R. I. Sc. N. B., Bresil" (purple label). Part of four legs are glued to a card beneath the specimen. The genitalia are in an attached vial. Deposited in the Institute Royal de Sciences Naturelles de Bruxelles.

*Paratypes.* 2♀♀, labeled as holotype; ♀ labeled "Brazil, Mato Grosso: Vila Vera, 52°30' long., 12°46' lat. Oct. 1973. M. Alvarenga."

### **Senectius, new genus**

*Type species.* *Senectius metallicus*, new species.

*Diagnosis.* Apex of head narrowly rounded, tylus a little longer than juga; lateral jugal margins concave above antennifers; anteocular processes lacking. Interocular width about half width of head across eyes. Imaginary line traversing head at posterior limit of reticulated part of eyes passing through ocelli when dorsum of head horizontal (Fig. 13). Antennae 5-segmented; basal segment reaching apex of head. Bucculae acutely toothed anteriorly, lobed posteriorly (Fig. 14). Basal segment of rostrum projecting beyond bucculae, rostral apex lying between metacoxae.

Scutellar length and basal width subequal; width of scutellum at distal end of frena nearly 2.5 of basal width. Costal angle of each corium reaching last tergite before genitalia. Anterior margins of propleura not produced. Ostiolar ruga on each side reaching about  $\frac{3}{4}$  distance from mesial margin of ostiole to lateral margin of metapleuron. Femora armed on inferior surfaces with pairs of small tubercles, each bearing seta (Fig. 15); tibiae sulcate dorsally.

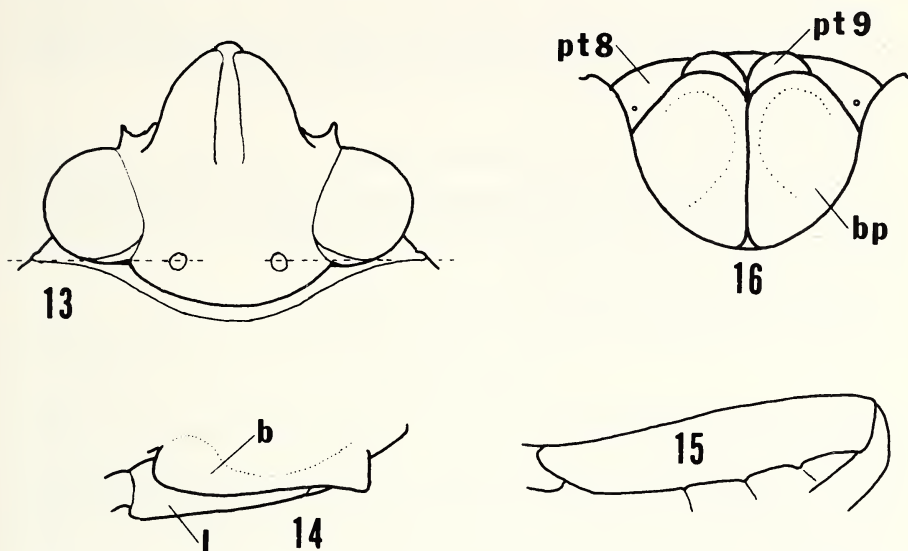
Prosternum shallowly concave longitudinally with weak medial carina anteriorly. Mesosternum weakly carinate medially. Metasternum nearly flat, sloping slightly ventrad from anterior to posterior margin.

### **Senectius metallicus, new species**

Figs. 13-16

*Description.* Ground color light brown to castaneous dorsally and light yellow to brownish yellow ventrally, with extensive areas of metallic green and black; a few ivory markings. Body length excluding hemelytral membranes about 7.5 mm.

Dorsum of head metallic green, rather flat before eyes, lateral jugal margins slightly reflexed. Width of head across eyes 2.05 mm, length from ocelli to apex 1.2-1.25 mm; interocular width 0.95-1.0 mm; distance across ocelli 0.7 mm. Ocelli about 0.1 mm in diameter. Basal part of first antennal segments pale, remainder of antennae black; length of segments 1-5 about 0.4-0.45, 1.0-1.1, 1.1-1.3, 1.6, 1.65 mm (fused 4+5 in holotype 2.5 mm long). Rostral segments 2-4 about 1.0, 1.0, 1.3 mm long; first segment and base of second pale, remainder of rostrum fuscous.



Figs. 13–16. *Senecticus metallicus*. 13. Head. 14. Buccula and basal segment of labium (b, buccula; l, labium). 15. Femur. 16. Genital plates (bp, basal plate; pt 8, paratergite 8; pt 9, paratergite 9).

Anterior, posterior and posterolateral pronotal margins and humeri bordered in metallic green. Transverse, impunctate band behind cicatrices and edge of anterolateral margins cephalad of this band, light yellow. Anterolateral margins nearly straight. Pronotal width at humeri 4.6 mm, mesial length 1.9 mm.

Mesial spot at base of scutellum, another at apex, ivory; tongue more or less metallic green. Width of scutellum at base 3.0 mm, at distal end of frena 1.1 mm; mesial length 2.9 mm.

Exocorium and posterolateral angle of endocorium of each hemelytron metallic green; adjacent area of endocorium blackish, impunctate, with ivory spot; corial spots and spot on scutellar apex nearly in line. Distal margin of each corium concave, costal angle acute. Membranes of hemelytra heavily fumose, projecting well past apex of body; veins numerous, simple.

Exposed portion of connexiva yellowish, immaculate excepting lateral edge of segments at and near posterolateral angles dark; these angles protruding slightly.

Venter of head yellow. Thoracic venter metallic green, excluding dark evaporative areas, with yellow as follows: on prothorax a narrow border along anterior margin between eyes, narrow border along posterior margin, and broad lateral borders; on mesothorax lateral borders and posterolateral corners; on metathorax posterolateral corners; area bordering each supracoxal cleft. Coxae, trochanters and basal region of middle and hind femora yellow, remainder of legs dark brown to black. Abdominal venter yellow with sternites 2–4 (first three visible) black exclusive of broad borders laterally and sometimes a pair of spots near meson of sternite 4; on remaining sternites sutures between them, pseudosutures, and mesial line may be dark in part or whole.



Basal plates convex proximally, quite concave distally, nearly reaching apex of abdomen (Fig. 16). Only apex of paratergite 9 exposed. Spiracles present on paratergite 8.

Male unknown.

*Distribution.* Peru (Madre de Dios).

*Holotype.* ♀, labeled "Ob Madre de Dios, Garlepp V." (green label); "Zool. Mus. Berlin" (yellow label). All of the left antenna except the basal segment, the tarsus of the left front leg, and the right middle leg beyond the trochanter are missing. Segments 4 and 5 of the right antenna are fused. Deposited in the Museum für Naturkunde an der Humboldt-Universität zu Berlin.

*Paratype.* ♀, labeled as holotype. Rostrum damaged.

#### ACKNOWLEDGMENTS

The genera and species described are based on specimens provided by Drs. U. Göllner-Scheiding (Museum für Naturkunde der Humboldt Universität), H. Schmitz (Institute Royal de Sciences Naturelles de Bruxelles) and Randall T. Schuh (American Museum of Natural History). I am indebted to Dr. Søren Langemark (Universitetets Zoologiske Museum) for the opportunity to examine the holotype of *Brasilania fabulirostris* Jensen-Haarup.

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**DIAGNOSIS OF *EPIPEDUS* SPINOLA AND REDESCRIPTION OF  
THE TYPE SPECIES, *E. HISTRIO* SPINOLA  
(HEMIPTERA: PENTATOMIDAE)**

L. H. ROLSTON

Department of Entomology, Louisiana Agricultural Experiment Station,  
Louisiana State University Agricultural Center,  
Baton Rouge, Louisiana 70803

*Abstract.*—The diagnostic characters of *Epipedus* Spinola, 1837, are enumerated and *Calagasma* Bergroth, 1914, synonymized with this genus. *Epipedus histrio* Spinola, 1837, type species by monotypy, is redescribed and a lectotype designated.

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*Epipedus* Spinola, 1837, a neotropical genus in the tribe Pentatomini, has been an enigma. The original diagnosis became inadequate with the accrual over the years of other genera in the tribe; and the syntypes of *E. histrio* Spinola, the type species by monotypy, were not generally available for study until the Spinola collection of Hemiptera was transferred in 1979 to the Museo Regionale de Scienze Naturali di Torino. Through the kindness of A. Casale, a syntype of *E. histrio* was loaned to me. The genus is redefined and the species redescribed from this specimen.

*Epipedus* Spinola, 1837

*Epipedus* Spinola, 1837:314-315. (Type species *Epipedus histrio* Spinola, 1837, by monotypy.)

*Calagasma* Bergroth, 1914:432-433. NEW SYNONYMY. (Type species *Calagasma margarita* Bergroth, 1914, by monotypy.)

*Diagnosis.* Juga strongly reflexed along lateral margins, converging over tylus apically. Relative to width of head across eyes: interocular width  $\frac{1}{2}$ , distance across ocelli from lateral margin of one ocellus to lateral margin of other  $\frac{2}{5}$ , length of head from apex to ocelli  $\frac{7}{10}$ . Antennifers entirely visible from above; antennae 4-segmented; basal segment surpassing apex of head. Bucculae evanescent near base of head; first rostral segment extending slightly past bucculae.

Anterolateral margins of pronotum entire, strongly reflexed from obtuse humeri to small tooth at each anterolateral angle; collar along anterior pronotal margin defined by deep sulcus.

Scutellum subgibbose basally. Basal angles lacking foveae. Scutellar length subequal to basal width; width at distal end of frena about  $\frac{1}{3}$  of basal width.

Prosternum slightly concave mesially, mesosternum weakly carinate, metasternum flat. Anterior propleural margins not produced. Each ostiolar sulcus spatulate, extending about  $\frac{1}{3}$  distance from mesial limit of ostiole to lateral margin of metapleuron.

Femora unarmed. Superior surface of tibiae rounded expecting apex may be flattened or broadly rounded.

Abdominal venter without mesial tubercle or spine at base.

*Comments.* Bergroth proposed *Calagasma* apparently because of a statement Spinola made, and one he did not make, in the diagnosis of *Epipedus*. Bergroth contrasted *Calagasma* with his concept of *Epipedus* thus: "Voisin du genre *Epipedus* Spin., mais bien distinct par la structure et la sculpture singuliere de l'escusson et par les tibias cylindriques, en dessus, nullement trigones." All Spinola wrote concerning the form of the scutellum was: "Escusson triangular; extremite arrondie, ne dépassant pas le quatrieme anneau dorsal." He did not mention the prominent basal tumescence, which Bergroth undoubtedly assumed was absent and cited as an important contrast between *Epipedus* and *Calagasma*. Spinola also wrote: "Tibias trigones." This statement is accurate only for the apices of all tibiae of *E. histrio*; the remainder of all tibiae of this species is cylindrical. As noted above, Bergroth stated that the tibiae of *C. margarita* are cylindrical. I do not believe that the differences between *Epipedus histrio* and *Calagasma margarita* are of more than specific value and therefore place *Calagasma* in the synonymy of *Epipedus*.

The type specimen of *Calagasma margarita* was not located. My concept of the species is based on Bergroth's detailed description.

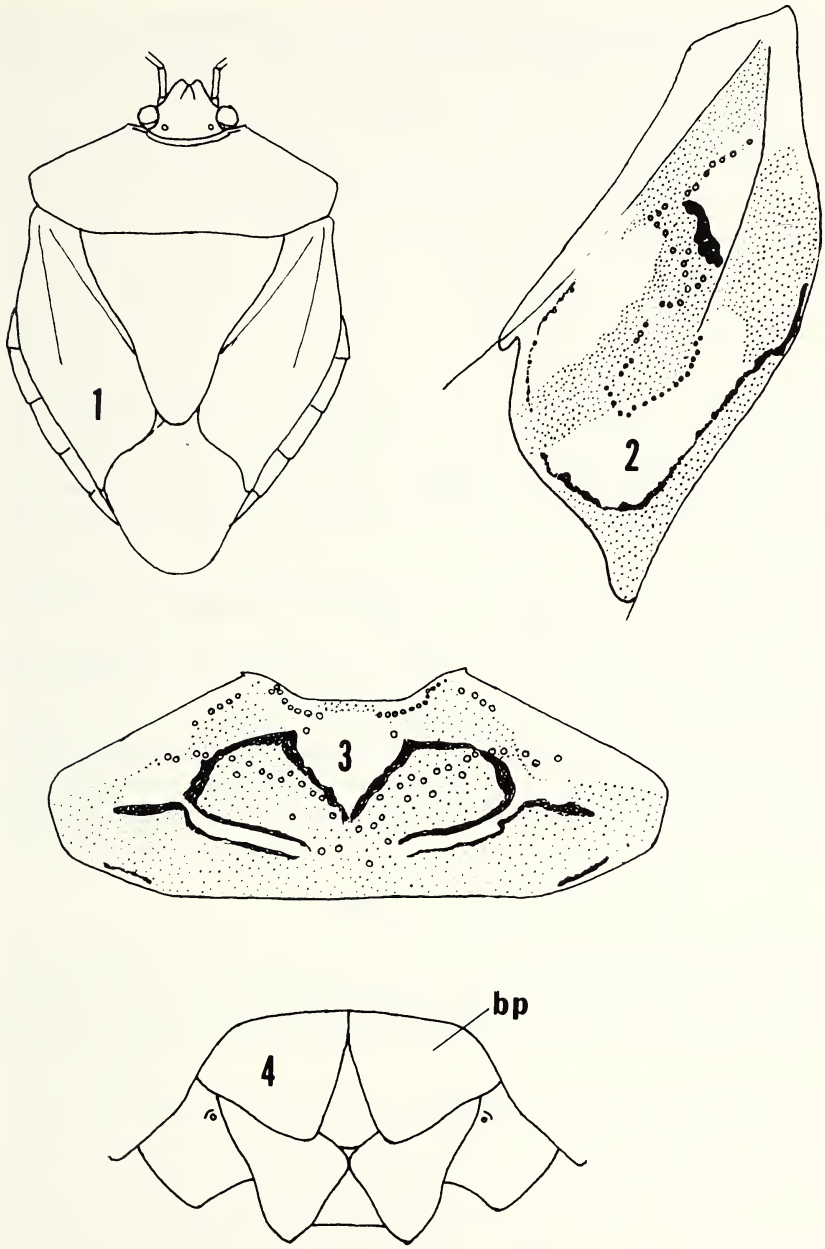
In the American Museum of Natural History there is a female specimen, determined by Ruckes as *Calagasma margarita*, which conforms to the description of that species except that the posterior slope of the scutellar tumescence is punctate. In this specimen the apices of the front tibiae are flattened above and triangular. The remainder of the front tibiae is cylindrical as are all of the middle and hind tibiae. The former divergence from the description may represent intraspecific variation and the latter an oversight by Bergroth. Alternatively, this specimen may represent a third species of *Epipedus*.

*Epipedus histrio* Spinola, 1837

*Epipedus histrio* Spinola, 1837:315–316.

*Redescription.* Head mostly rufous; tylus black with rufous lateral margins and brownish yellow base; vertex brownish yellow, bordered on each side by black line curving toward eyes anteriorly. Punctuation consisting of single row of punctures on each side of vertex; most punctures within black line, a few anterior to it where black line diverges toward eye. Tylus slightly longer than juga, appearing shorter when insect viewed dorsally because of strongly reflexed lateral margins of juga (Fig. 1); these margins slightly sinuous. Width of head across eyes 2.45 mm; length from apex to ocelli 1.95 mm; interocular width 1.25 mm; distance from outer margin of one ocellus to outer margin of other 1.05 mm. Antennal segments 1–4 about 0.8, 3.6, 2.6, 2.5 mm long; basal segment rufous, remaining segments brownish yellow with distal tenth of second and distal halves of third and fourth fuscous. Rostral segments 2–4 about 1.1, 7.5, 8.5 mm long; apex of rostrum reaching posterior limits of mesocoxae.

Pronotum brownish yellow; extensive rufous markings partially enclosed in black (Fig. 3). Row of punctures in sulcus behind collar continuing submarginally for short distance along anterolateral margins; V-shaped, sparsely punctate band of punctures divides pronotum transversely; pronotum elsewhere impunctate. Cicatrices obscure. Humeri little produced, obtusely angulate. Pronotal width 7.4 mm at humeri, mesial length 2.5 mm.



Figs. 1-4. *Epipedus histrio*. 1. General form, dorsal view. 2. Right corium. 3. Pronotum. (Rufous areas of pronotum and corium indicated by stippling.) 4. Genital plates; basal plates (bp) slightly opened.



Scutellum mostly rufous; brownish yellow macule covering most of mesial half of scutellar base impunctate; base of scutellum on each side, macule and border along most of frenal margins brownish yellow, much of this border outlined in black. Low, median carina extending from basal tumescence becoming obsolete before apex. Scutellum 4.8 mm wide at base, 1.6 mm wide at end of frena, 4.7 mm long.

Costal margin of each corium strongly reflexed basally; posterior margin sigmoid; costal angle acute, rounded (Fig. 2). Membrane slightly fumose with about 10 veins, extending beyond apex of abdomen. Endocorium brownish yellow, punctation black. Exocorium brownish yellow with extensive rufous suffusion (stippled area in figure). Narrow, black, mostly submarginal border along distal part of costal margin continues with diminished clarity around posterior corial submargin and extends short distance along claval suture. Large, impunctate or very sparsely punctate area mesad of R+M vein divided by large, black macule; proximal impunctate area triangular, brownish yellow; distal area very sparsely punctate, rufous (limit of these areas indicated by punctures and vein in figure); punctation in brownish yellow areas black, in rufous areas concolorous excepting small patch of black punctures between distal end of R+M vein and submarginal black line; basal area between costal margin and R+M vein somewhat scabrous, not distinctly punctate. Connexiva broadly exposed, immaculate.

Venter brownish yellow excepting femora apically, tibiae, tarsi and broad border along lateral margins of head rufous. All tibiae broadly, shallowly sulcate apically, otherwise cylindrical. Genital plates as in Figure 4.

Body widest across second visible segment of abdomen, 8.5 mm. Body length including membranes 12.2 mm.

*Lectotype*. Spinola based the genus and species *Epipedus histrio* on two female specimens that are still extant. However, one specimen, which I have not seen, lacks the head. The other specimen is reasonably intact but lacks the last segment of the left antenna, the right middle leg and the left hind leg. This specimen, now labeled "*Epipedus histrio* Spin., D. Buquet, Bresil, (cotype)," is designated lectotype.

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**A SECOND SPECIES OF *PARVAMIMA* RUCKES  
(HEMIPTERA: PENTATOMIDAE: DISCOCEPHALINAE)**

L. H. ROLSTON

Department of Entomology, Louisiana Agricultural Experiment Station,  
Louisiana State University Agricultural Center,  
Baton Route, Louisiana 70803

*Abstract.*—*Parvamima mexicana* is described as new from Jalisco, Mexico.

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Ruckes (1960) established *Parvamima* as a monotypic genus for *P. bicolor*, a species he described from a female collected on Barro Colorado Island, Panama. Engleman (1977) subsequently described the male, permitting further characterization of the species. A second species of the genus is described from a male taken in the Mexican state of Jalisco. The male genitalia of both species are figured to facilitate comparison.

The following combination of characters apparently separate *Parvamima* from other genera in the tribe Discocephalini: length of head subequal to interocular width; metasternum strongly produced, flat ventrally, excavated posteriorly in apposition to stout, mesial tubercle on abdominal sternite 3 (second visible); anteocular process absent; scutellar apex lying between imaginary line connecting anterolateral angles of fifth abdominal segment and similar line connecting posterolateral angles of same segment.

To the generic description provided by Ruckes (1960) may be added: mesial process present in posterior emargination of tergite 7 of male; a basally articulated appendage on each side of pygophore; sternite 8 with vestigial spiracles; pair of thecal appendages present.

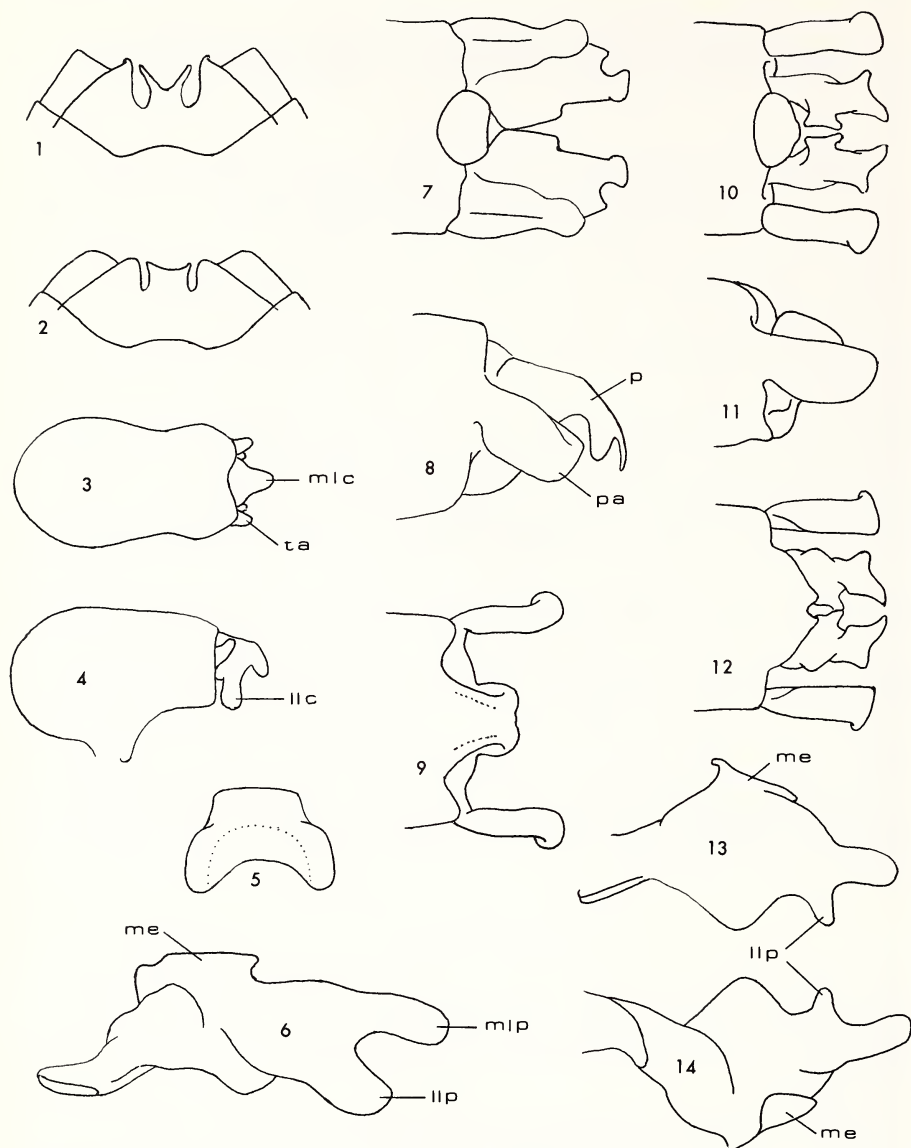
***Parvamima mexicana*, new species**

Figs. 2, 10-14

Similar in form and size to *P. bicolor*, apparently differing in shorter rostrum, in less developed mesosternal carina, and in coloration and punctation; and markedly differing in form of mesial projection on posterior margin of tergite 7 of male and in male genitalia.

Rostrum reaching anterior margin of metasternum (reaching from slightly beyond this point to middle of metasternum in *P. bicolor*). Mesosternal carina weakly developed (moderately developed in *P. bicolor*). Dorsum sordid yellow with dark punctation, but pronotum behind transhumeral line and subbasal macule on scutellum dark brown (all of dorsum behind transhumeral line dark brown in *P. bicolor*). Punctation on scutellum rather sparse basally. Sternite 7 of male with brown, mesial macule near anterior margin; mesial process in posterior emargination of tergite 7 nearly square with posterolateral corners projecting slightly (Fig. 2).

Pygophore completely submerged in abdomen, visible only from caudal view. Pygophoral appendages long, stout (Figs. 10-12). Parameres large, curving ventrad,



Figs. 1-14. 1, 3-9. *P. bicolor*. 1. Seventh tergite and connexival segments. 3. Theca and related structures, dorsal aspect. 4. Same, lateral aspect. 5. Proctiger. 6. Left paramere. 7. Distal end of pygophore, dorsal aspect. 8. Same, lateral aspect. 9. Same, ventral aspect with parameres omitted. 2, 10-14. *P. mexicana*. 2. Seventh tergite and connexival segments. 10. Distal end of pygophore, dorsal aspect. 11. Same, lateral aspect. 12. Same, ventral aspect. 13. Left paramere, superior surface. 14. Same, rotated 180 degrees. Symbols: llc, lateral lobe of conjunctiva; llp, lateral lobe of paramere; me, medial expansion of paramere; mlc, medial lobe of conjunctiva; mlp, medial lobe of paramere; p, paramere; pa, pygophoral appendage; ta, thecal appendage.

bifurcate distally; each lobe of bifurcation narrowly rounded apically, lateral lobe much smaller than mesial lobe; medial expansion bent ventrad, constricted at base (Figs. 13, 14).

*Measurements* (mm). Width of head across eyes 2.4, length 1.5. Width of pronotum 5.2, mesial length 2.4. Basal width of scutellum 3.5, length 3.8. Length of antennal segments I–IV 0.50, 0.70, 0.75, 1.25, —. Length of rostral segments I–IV about 0.5, 0.9, 0.5, 0.35. Length of body excluding hemelytral membranes 8.6. Ostiolar ruga on each side extending  $\frac{3}{5}$  of distance from medial limit of ostiole to lateral margin of metapleuron.

*Proportions*. Distance between ocelli  $\frac{3}{5}$  of interocular width. Distance from each ocellus to nearest eye  $\frac{1}{4}$  of distance between ocelli. Width of head across eyes  $\frac{2}{3}$  of basal width of scutellum.

*Holotype*. Male, labeled (1) "Mexico, Jalisco, Mismaloya, 2-VIII-84, E. Ibarra" and (b) "Colección del Instituto de Biología UNAM. Mexico, D.F." Deposited in the Instituto de Biología, Universidad Nacional Autónoma de México. The femora, tibiae and tarsi of all but the left hind leg are missing, as are the fifth segment of the left antennae and the fourth and fifth segments of the right antennae. No paratypes.

#### ACKNOWLEDGMENT

The specimen from which *P. mexicana* is described was loaned by Harry Brailovsky, UNAM.

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## **DEREPHYSIA FOLIACEA (FALLÉN), A TINGIDAE NEW TO NORTH AMERICA (HEMIPTERA: HETEROPTERA)**

JOHN D. LATTIN

Systematic Entomology Laboratory, Department of Entomology,  
Oregon State University, Corvallis, Oregon 97331

*Abstract.*—*Derephysia foliacea* (Fallén) (Hemiptera: Heteroptera: Tingidae) is recorded from North America for the first time, based upon specimens collected in western Oregon, chiefly on or near Mary's Peak, Benton County, Polk County, and the H. J. Andrews Experimental Forest, eastern Lane County on the west slope of the Cascade Mountains. Several other Holarctic genera and species of Hemiptera: Heteroptera occur with *D. foliacea*, suggesting a true Holarctic distribution rather than an introduction. In the Palaearctic Region, the tingid is known from Western Europe, North Africa and eastward to Siberia, Mongolia and Japan.

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Our knowledge of the Tingidae of North America is quite good at the generic level. Many genera remain to be monographed and much remains to be discovered about the biology of many species, particularly in western North America. A small collection of Heteroptera collected by my colleague Paul Oman from nearby Mary's Peak in 1968 proved to be of particular interest when two females of an unknown lacebug were included. Ultimately, an identification was made (and confirmed by Richard C. Froeschner of the Smithsonian Institution), that of *Derephysia foliacea* (Fallén), known previously only from the Old World. Considerable effort has been made to collect additional specimens but with only limited success. While some adults have been collected, the immature stages still elude us as they do our European colleagues.

Available evidence suggests that *Derephysia foliacea* is native to the Pacific Northwest rather than being an introduction and thus it joins a rather distinct group of palaearctic extensions into the Pacific Northwest at both the generic and specific level. Examples among the Miridae include *Allorhinocoris* (Bliven, 1960) and *Anapus* and *Myrmecophyes* (Schuh and Lattin, 1980); the Rhopalidae includes *Chorosoma* (unpubl.), and the Tingidae included *Acalypta cooleyi*; Drake (Froeschner, 1976) although this last example may represent an extension into the eastern Palaearctic Region.

*Derephysia foliacea* was described from Sweden by Fallén in 1807 (as *Tingis*). Drake and Ruhoff (1965) record it from Europe, North Africa and eastward to Siberia. Lindberg (1927) reported it from Nikolajewsk in the Amur Region of far eastern U.S.S.R., although Josifov and Kerzhner (1972) did not record it from Korea. Pericart (1978) revised the genus for the western Palaearctic Region and later, in his marvelous treatise on the Euromediterranean Tingidae (1983), provided a thorough review of the genus *Derephysia*, including *foliacea*. Butler (1923) described the egg and Stusak (1957) and Puchkov (1970, 1974) described and illustrated the larva. Illustrations of the adult are found in Scholte (1935), Southwood and Leston (1959), Kerzhner and Jaczewski (1967), Puchkov (1974) and Pericart (1978, 1983), among others. A number of host plants are listed by Drake and Ruhoff (1965) but specific host in-

formation is very limited. Southwood and Leston (1959) refer to the species as the "ivy bug." Stusak mentions that nymphs were taken in the moss *Climacium dendroides* W. and M. in a meadow in August. Puchkov (1974) provided additional host information. Pericart (1983) summarizes the available host information and mentions the possible association of this species with ants citing Reuter (1880) and Singer (1952).

The first specimens collected from North America were the two females collected on August 7, 1968 by Paul Oman in the summit meadow on Mary's Peak, Benton County, Oregon. Mary's Peak is 14 miles west of Corvallis and is the highest point (1,249 meters) in the Coast Ranges of Oregon. While most of the mountain is covered with a typical Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg. forest, there is a natural grass bald at the summit that is surrounded by noble fir (*Abies procera* (Rehd), together with scattered Douglas fir and western hemlock (Franklin and Dyrness, 1973). Merkle (1951) states that the meadow is composed chiefly of Idaho fescue (*Festuca idahoensis* Elm.), bent grass (*Agrostis diegoensis* Vas.) and California sedge (*Carex californica* L. H. Bailey). According to Kenton Chambers (pers. comm.), the correct identity of the fescue is *Festuca rubra* L.

The following specimens have been examined (all specimens in Systematic Entomology Laboratory, Oregon State University, except as noted): Oregon: Benton County: Mary's Peak, 7 August 1968 (P. W. Oman); 29 August 1968 (R. W. Westcott, Oreg. St. Dept. Agr.); 18 August 1970, 3,800 ft, (Oman, Brandenburg and Rowers); 8 September 1971, summit meadow at campground 3,600 ft, (J. D. Lattin) (also specimens in U.S. National Museum); October 1976 (J. D. Lattin); Grass Mountain, summit prairie, sweeping, 14 August 1980 (J. D. Lattin); Corvallis, 28 July 1973 (J. Lattin); Lobster Valley, 15 mi SW Alsea, 25 July 1971 (J. D. Lattin) and 14 July 1973 (J. D. Lattin); Lane County: Blue River, H. J. Andrews Exp. For., Old age Doug. Fir stand, I. B. P. Biome Survey, Rotary net, 1-3:30 PM, 3 August 1972; Lane/Linn Co., H. J. Andrews Exp. For., access road #1553, nr. Mack Creek, 2.5 mi W Jct 1502-1553, ex sweeping, 2 August 1977 (Eulensen and Searles); Lane Co., Andrews Exp. For. T15S R5E Sec 31, 6 August 1980 (Oman); Lane/Linn Co., H. J. Andrews Exp. For. meadow, ½ mi N Frissel Pt. T15S R6E Sec 29 SW¼, 4,850 ft, 2 September 1981 (J. D. Lattin). Marion County: Croisan Gulch, S. Salem, 28 July 1976 (R. L. Westcott, Oreg. St. Dept. Agr.); Polk County: Independence, July 1975 (L. Russell).

The known distribution of *D. foliacea* in North America is limited to several locations in the Coast Ranges of western Oregon, west of Corvallis, a few scattered localities directly east of the localities and one location on the west slope of the Cascade Mountains east of Eugene (H. J. Andrews Experimental Forest, a National Science Foundation, Long Term Ecological Research Site). Only three collection sites have produced more than a single specimen (Mary's Peak, Grass Mountain [Coast Range] and the meadow north of Frissel Point on the H. J. Andrews Forest (Cascade Mountains). These sites are all natural meadows occurring at some elevation (1,200-1,500 m) in an undisturbed forest habitat. The single specimens from scattered, low elevation localities, mostly males, suggests that there may be a dispersal flight in mid- to late summer that may result in specimens being carried away from these

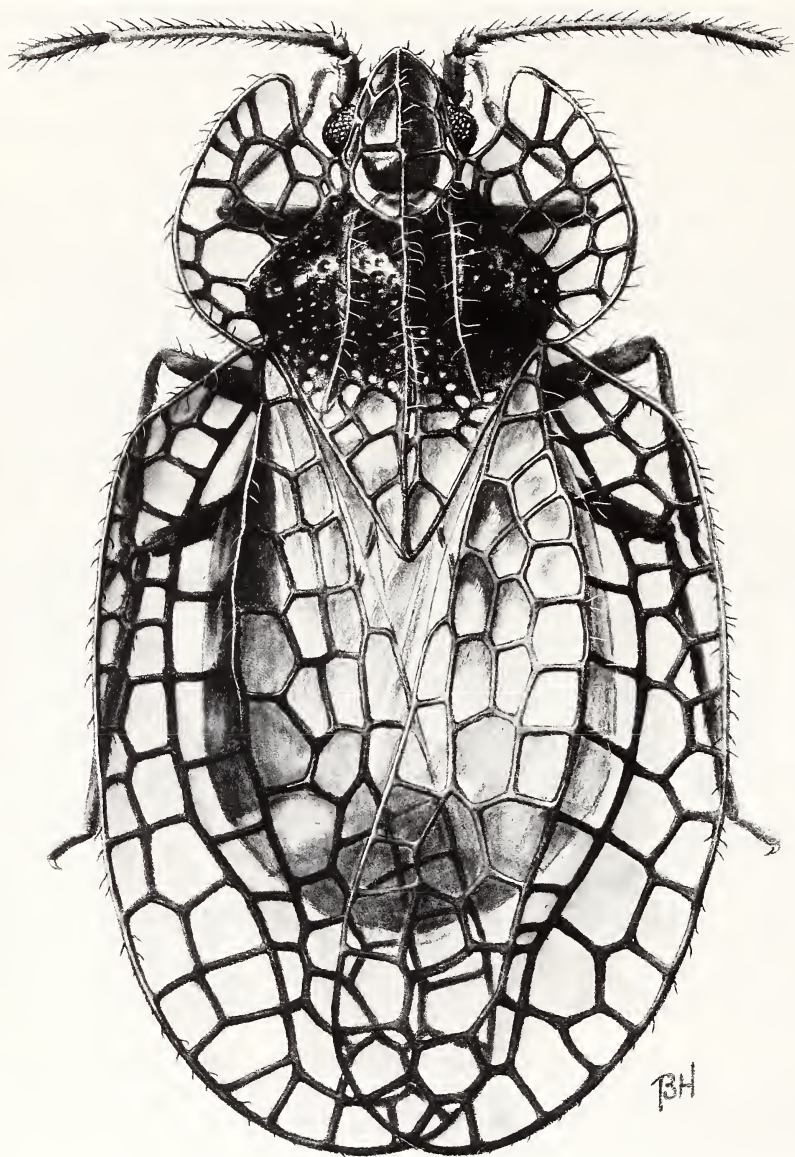


Fig. 1. *Derephysia foliacea* (Fallén).



montane meadows. Southwood and Leston (1959) report on the flight of this species in England and one specimen was collected from a rotary trap in early August at lower elevations on the H. J. Andrews Forest.

The Tingidae fauna of Oregon is reasonably well known although a number of genera and species are represented by very few specimens. The following genera and number of species are presently known from Oregon: *Acalypta* (3 spp.), *Corythucha* (8–10 spp.), *Derephysia* (1 sp.), *Dictyonota* (1 sp.), *Gargaphia* (2 spp.), *Hesperotingis* (1 sp.), *Melanorhopala* (1 sp.), *Monanthia* (1 sp.), *Physatocheila* (1 sp.), *Stephanitis* (1 sp.), *Teleonemia* (2 spp.). There is a possibility that *Leptopypha minor* McAtee will be found in southwestern Oregon since the known host plants are found there and it occurs in nearby California. Two of the species included above, *Dictyonota fuliginosa* Costa and *Stephanitis rhododendroni* Horváth, are considered to be introductions, the first from Europe on Broom (*Sarothamnus scoparius*) and the second from eastern United States on cultivated rhododendrons (note: it has not been collected on the native Oregon species of rhododendron to date). The discovery of *Derephysia foliacea* in Oregon represents an interesting addition to our fauna.

#### ACKNOWLEDGMENTS

Thanks are due to Richard C. Froeschner, Smithsonian Institution, for verifying the identification of this tingid; to Paul Oman, Oregon State University, for the use of his field notes on the initial and subsequent captures of this bug; to Jean Pericart, Montereau, France for valuable discussions on the Tingidae; and to Bonnie B. Hall for the excellent habitus drawing of the adult.

Note: It is a pleasure to contribute this paper in honor of my long time friend and colleague, Richard C. Froeschner. Our association dates back to my undergraduate days at Iowa State University. Dick Froeschner freely shared his considerable knowledge of insects, including the Heteroptera, with me then and over the years of our friendship since that time.

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## A REVISION OF THE GENUS *DUSHINCKANUS* WITH DESCRIPTIONS OF TWO NEW SPECIES (HEMIPTERA: LYGAEIDAE)

B. J. HARRINGTON

Department of Entomology, University of Wisconsin,  
Madison, Wisconsin 53706

**Abstract.**—A diagnosis for the Neotropical genus *Dushinckanus* and a key for species identification are presented. *Myodocha inermiba* Distant is transferred to *Dushinckanus*, new combination, and two new species, *D. ashlocki* from Brazil, and *D. camelopardus* from Ecuador are described. Line drawings of the head and pronotum of *D. camelopardus* and *D. ashlocki* and a full dorsal view illustration of a male of *D. crassicornis* Brailovsky, 1981 are provided.

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The Neotropical lygaeid genus *Dushinckanus* Brailovsky belongs to the tribe Myodochini in the subfamily Rhyparochrominae. This genus was not included in Harrington's (1980) revision and cladistic analysis of the tribe. However, utilizing that key to genera, it would run to couplet number 3 which separates *Pepphysena* and *Myodocha*. While *Dushinckanus* does have slender forefemora in common with *Myodocha*, its cladistic affinities lie instead in the lineage with *Distingphyses* Scudder, *Pepphysena* Distant, *Tenuicoris* Slater and Harrington, and *Neopamera* Harrington (internode 36-44 in Harrington's (1980) cladogram) based on the synapomorphy of a groove on the lateral surface of the preocular portion of the head beneath a carinate or ridge-like jugum. It shares oval eyes and a head with the postocular portion constricted to form a distinct neck with *Distingphyses*, *Pepphysena*, and *Tenuicoris*; densely distributed anastomosing head punctation with *Distingphyses* and *Pepphysena*; and a characteristic stalk-like neck with *Pepphysena*. *Dushinckanus*' slender, almost mutic forefemora readily distinguish it from its sister group *Pepphysena*.

When Brailovsky (1979) described *Dushinckanus*, he placed it in the framework of Harrington's (1980) tribal revision and discussed ways to distinguish it from *Myodocha*, *Pepphysena*, *Tenuicoris* and *Heraeus* Stål, stressing what he believed to be two diagnostic features: 1) slender forefemora with spination reduced to a few minor spines, and 2) "protuberant" or tuberculate ocelli. While this latter feature is very pronounced in the type species *D. ocellatus* Brailovsky (1979), it varies within the genus. In some members, including *Dushinckanus crassicornis* Brailovsky (1981), the second species recognized to date, the ocelli may be virtually flush with the head's surface and show no more tuberculation than can be observed in many other Myodochini, including members of the genera *Xenydrium* Poppius and Bergroth, *Tenuicoris*, and *Heraeus*.

Thus, the first feature, slender forefemora with few spines, remains the best for recognition of the genus *Dushinckanus*. Among the necked genera of Myodochini, only members of *Tenuicoris*, *Myodocha* Latreille and *Dushinckanus*, all having Type IV male genitalia (Harrington, 1980), have slender forefemora with the size as well as the number of spines reduced. In both *Tenuicoris* and *Myodocha* the spines are

double-ranked (those on the posterior aspect of the ventral surface in *Tenuicoris* being very small, restricted to a few close-set spines on the extreme distal end, and distinguished only with difficulty), while all known species of *Dushinckanus* have the spines single-ranked or restricted to just the anterior aspect of the ventral surface. In *Dushinckanus* the spines are also often so small, bump-like and little raised from the femoral surface that they may be overlooked entirely. This was clearly the case when Distant (1882) described *Myodocha inermiba*, noting that, "The unarmed femora render this species very distinct."

In the current paper I place *M. inermiba* in *Dushinckanus*, new combination and describe two new species. A single specimen lacking locality data (the specimen is in good condition but bears a label reading only "28-III") was examined from the American Museum of Natural History. It will probably prove to represent another distinct species. Material of *Dushinckanus* is scarce in collections, all species being known from a few specimens. However, the genus is widely distributed, ranging from Mexico south at least to Rio de Janeiro, Brazil. I collected a single specimen in Panama and from its habitat suspect that the genus may be part of a forest litter fauna that is not generally collected.

All measurements in the following descriptions are in mm and the Villalobos color chart (Palmer, 1962) has been used as a standard. The following acronyms for collections have been used in the text: American Museum of Natural History, New York (AMNH); British Museum (Natural History), London (BMNH); National Museum of Natural History, Rio de Janeiro (BNMNH); Carnegie Museum of Natural History, Pittsburgh (CMNH); National Museum of Natural History, Washington, D.C. (NMNH); private collection of Peter D. Ashlock (PDA); private collection of James A. Slater (JAS); and private collection of the author (BJH).

KEY TO SPECIES OF *DUSHINCKANUS*

1. Immediate postocular portion of head rounded or dome-like, then abruptly constricted into a short neck (Fig. 1b); postocular distance usually less than or subequal to interocular distance; length of antennal segment III less than width of head, and length of antennal segment II less than or equal to width of head; transverse pronotal impression strongly incised, with punctures in depth of impression

2

- Postocular portion of head sloping gradually into stalk-like neck (Fig. 1a); neck long and slender with postocular distance greater than interocular distance; lengths of antennal segments II and III each exceeding width of head; transverse pronotal impression shallow, complete, impunctate

4

2. Postocular portion of head, pronotum, scutellum, and hemelytra hirsute, with numerous semi-erect long hairs, those on hemelytra emerging from punctures and 3× or more as long as puncture's width; antennal segments III and IV appearing somewhat incrassate with dense hairs or bristles; punctures of transverse pronotal impression forming a row in depth of impression; ocelli only slightly tuberculate

*crassicornis*

- Not hirsute as above, sometimes with long hairs present on postocular portion of head but rest of dorsal body surface hairless or at most with very short non-erect hairs detectable within the punctures and subequal to the puncture's width; antennal segments III and IV not appearing incrassate; punctures of transverse pronotal impression not in a regular row; ocelli markedly tuberculate

3

3. Veins on posterior one-half of hemelytral membrane (beyond prominent dark macula on anterior one-half) dark, contrasting with membranous background; antennal segment



- IV completely dark; antennal segment III longer than segment II or the segments subequal ..... *ocellatus*
- Veins on posterior one-half of hemelytral membrane (beyond prominent dark macula on anterior one-half) pale, lighter than membrane background; antennal segment IV with a broad, striking, light red annulus that contrasts with dark areas proximally and distally; antennal segment II longer than segment III ..... *ashlocki*
4. Posterior pronotal lobe with a distinct, narrow, continuous, yellow, transverse band on its anterior one-half; antennal segment II orange, lighter than other three segments which are each uniformly dark; length of antennal segment III less than  $3 \times$  interocular distance; total length of antennal segments less than  $10 \times$  interocular distance ..... *inermibus*
- Yellow portion of posterior pronotal lobe not a continuous band, less apparent and present as mottling or as four diffuse patches that may run onto posterior one-half of posterior pronotal lobe; antennal coloration not as above, all four segments fairly uniform in color; length of antennal segment III greater than  $3 \times$  interocular distance; total length of antennal segments greater than  $10 \times$  interocular distance .... *camelopardus*

*Dushinckanus crassicornis* Brailovsky

Fig. 2

*Dushinckanus crassicornis* Brailovsky, 1981:217–219.

**Discussion.** Brailovsky (1981) gave a detailed description of this species which is best recognized by the scattered long hairs on the dorsal surface, including the head, pronotum, scutellum, clavus and corium. The incrassate antennae, which prompted the species epithet and are noted in the original description, are an unreliable feature exhibiting variability as discussed below.

I have examined the holotype from the American Museum of Natural History and six additional specimens. While the color pattern is consistent among them, the general or background coloration varies, ranging from predominantly tawny in a pale specimen from the Panama Canal Zone to a dusky brown in darker specimens including the holotype.

More striking than the color variation is the morphological variation in head shape and the shape of the third and fourth antennal segments. In all specimens examined the third antennal segment has numerous dark, bristle-like hairs that give an enlarged, bottle brush appearance to the segment. In the holotype, which is a female, the third and fourth antennal segments are definitely incrassate, as well as evidencing the dark bristle-like hairs on the third segment. The antennae were similarly incrassate in one of the two other female specimens examined; the third female, unfortunately, had the third and fourth antennal segments missing. The remaining four specimens examined were males in which the third and fourth segments are not swollen, the third being of the same girth as the second, despite a somewhat enlarged appearance contributed by the dark, bristle-like hairs. Thus, sexual dimorphism is suggested for the antennal variation in this species, and Figure 2 depicts a male specimen with slender antennae. However, sexual dimorphism does not explain the subtle variation in head shape observed. The vertex of the head was evenly rounded behind the ocelli in the holotype and more pointed in the other six specimens, females as well as males.

**Material examined.** **Guatemala:** 1♀, Peten (at light at camp), 17-V-1956, T. H. Hubbell (holotype *D. crassicornis*, AMNH). **Mexico:** 1♀, Veracruz, Lake Catemaco,



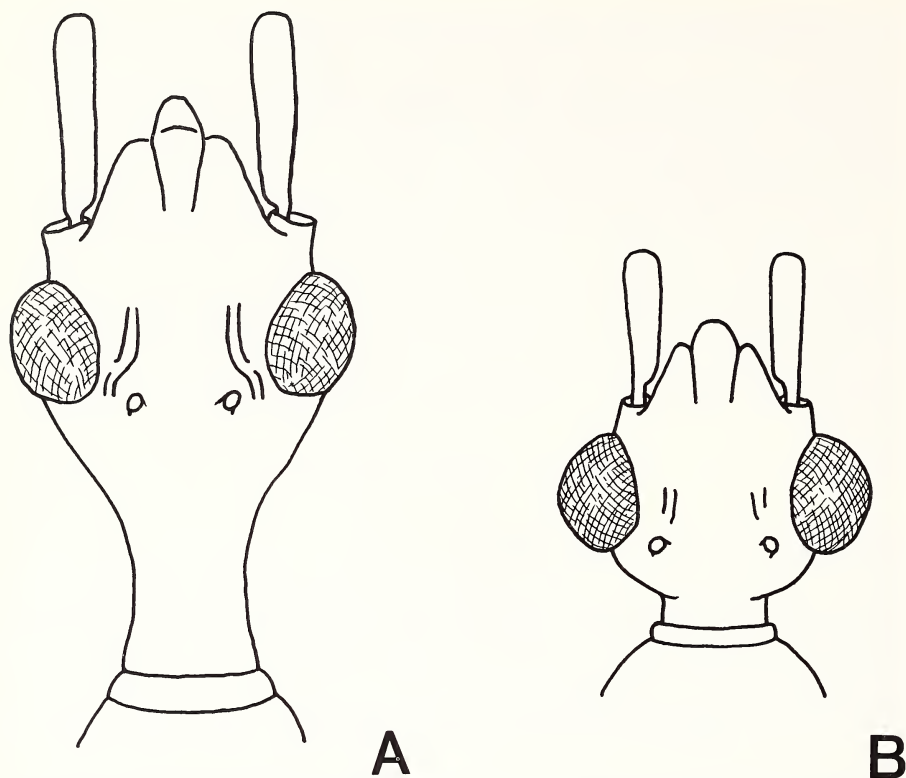


Fig. 1. Head/neck shapes: A. *Dushinckanus camelopardus*. B. *Dushinckanus ashlocki*.

'Coyame,' 7, 9-VII-1963, R. E. Woodruff (blacklight trap) (JAS). **Panama Canal Zone:** 1♀, Barro Colorado, 19-VI-1924, N. Banks (AMNH); 1♂, Barro Colorado I, 21-IX-1976, R. B. & L. S. Kimsey (PDA); 1♂, Barro Colorado Is., 8-VII-1967, C. W. & L. O'Brien (JAS). **Panama:** 1♂, Fort Amador, II-1964, Ch. Keenan (NMNH); 1♂, La Mesa above El Valle, 13-I-1974, Harrington & Slater (BJH).

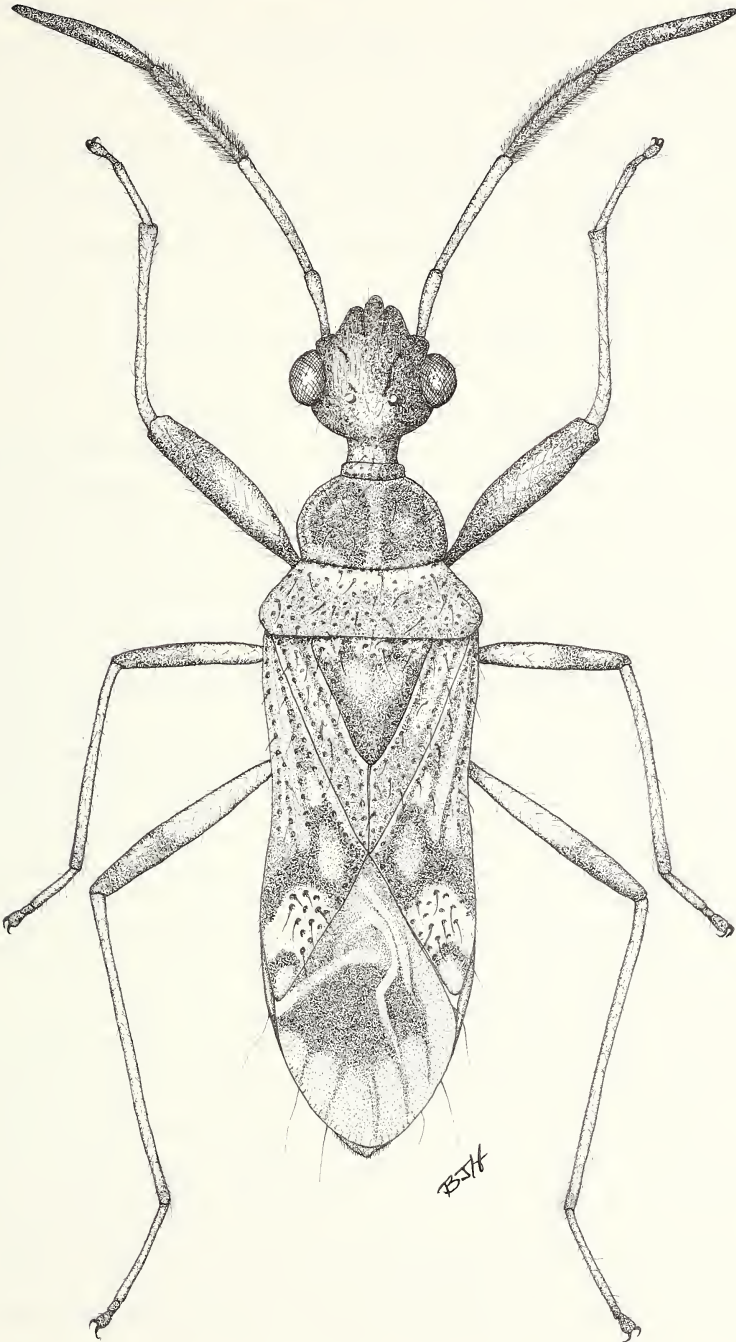
*Dushinckanus ocellatus* Brailovsky

*Dushinckanus ocellatus* Brailovsky, 1979:549-551.

**Discussion.** Brailovsky (1979) described this species as the type of a then monotypic genus. It is best recognized, as the name suggests, by its tuberculate ocelli. *D. ocellatus*, in fact, presents the extreme of this condition which varies considerably among species in the genus, and in some the ocelli are little, if at all, tuberculate.

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Fig. 2. *Dushinckanus crassicornis*. Dorsal view of a male specimen exhibiting sexually dimorphic slender antennae.



*Material examined.* **Brazil:** 1♂, Mato Grosso: Lat. 12°31' & Long. 55°37', Sinop, X-1974, M. Alvarenga (holotype *D. ocellatus*) (NMNH); 1♀, Rondonia: Vilhena, XI-1973, M. Alvarenga (allotype *D. ocellatus*) (AMNH); 1♀, Rio de Janeiro, Acc. No. 2966 (CMNH).

*Variation.* The female specimen from Rio de Janeiro is of an overall lighter color, especially on the head and pronotum, and has a shorter neck and somewhat less rounded anterior pronotal lobe than the holotype and allotype. However, the general color pattern is consistent with that of the type material.

A male paratype of *D. ocellatus* was also examined and is recognized in this paper as a new species.

### ***Dushinckanus ashlocki*, new species**

Fig. 1B

*Dushinckanus ocellatus* Brailovsky, 1979:551 (♂ paratype).

*Description.* Head, anterior pronotal lobe, basal one-half of scutellum and most of ventral and lateral aspects of all thoracic segments chestnut. Posterior pronotal lobe, medial portion of anterior pronotal collar, metepimeron, socket around pro- and mesocoxae (formed by both episternum and epimeron), and labial segment I buffy brown. Remaining labial segments, tarsi and tibia of all legs, and antennal segments I and II sordid buffy yellow. Antennal segment III buffy brown proximally darkening gradually to fuscous on distal two-thirds. Antennal segment IV narrowly fuscous proximally and more broadly so at apex, a broad band covering most of segment bright rufous tinged with brownish red. A diffuse band between tawny and buffy yellow extending across posterior pronotal lobe behind transverse impression, widest in two broad points on either side of midline. Background color of clavus and corium between buffy brown and buffy yellow. An indistinctly margined broad transverse buffy brown fascia on corium extending from lateral margin to medial corial angle. Five small, pale, cream colored maculae on each corium distributed with a pair directly before and a second pair directly posterior to dark band or fascia and the fifth behind posterior pair fitting within apical corial angle. Hemelytral membrane with a smoke gray background marked with a large macula between fuscous and blackish brown on anterior one-half; two curving veins toward anteromedial margin and finger-like veins posterior to broad dark macula a pale sordid cream. Abdomen laterally and ventrally and broad preapical bands on all femora tawny.

Antennae, legs and labium smooth and impunctate. Antennae with both fine recumbent hairs and some slightly longer and erect or semi-erect; density of recumbent hairs increasing distad, with segment IV being most pilose. Legs and labial segments with only sparse semi-erect hairs. Tibiae of all legs also bearing scattered bristles along length of inner surface. Head shining, with numerous small anastomosing punctures giving a rugose appearance and moderately dense recumbent and semi-erect hairs directed anteriorly over much of surface; rounded postocular region with a few very long (ca. 0.20) curving erect hairs. Pronotum, scutellum, clavus, corium and most of ventral and lateral aspects of all thoracic segments pruinose, except small subshining lobe on metathoracic scent gland auricle and a pair of large shining patches on either side of mesosternal midline. Anterior pronotal lobe, save collar,

impunctate. Anterior pronotal collar, posterior pronotal lobe, clavus, corium and scutellum except for a broad T-shaped carina on posterior two thirds punctate. Punctures on basal one third of scutellum smaller than those on either side of stem of T. Claval punctures in three regular rows plus a partial fourth, paralleled by two rows of punctures on adjacent portion of corium. Punctures laterally on corium in a single submarginal row from anterior margin to level of scutellar apex, thereafter scattered in a broad patch. Punctures laterally on thorax most dense and apparent on epimeral regions of all three segments and episternum only in the portion forming a socket for the pro- and mesocoxae. A large rugose or shagreened evaporative area surrounding the metathoracic scent gland auricle, reaching midway on metepisternum toward hemelytral edge, also covering coxal socket portion of mesepimeron and running from there dorsad to hemelytral edge as a thin line along suture between meso- and metapleura. Abdomen ventrally and laterally subshining, with a light scattering microtexture and numerous fine recumbent hairs. Hairs on thorax, clavus and corium also recumbent but scattered, emerging primarily from punctures and approximately as long as puncture's width. Hemelytral membrane dull, subshining, with a very fine granular appearance.

Head gently declivent anteriorly from vertex; broadly rounded postocularly then abruptly constricted to form a very short but still parallel-sided and stalk-like neck. Juga narrowly carinate. Tylus nearly attaining distal end of antennal segment I. Eyes rounded. Ocelli prominent and moderately tuberculate, situated just anterior to hind margin of eye. Length of head 1.10; postocular length 0.26; width across eyes 1.06; interocular distance 0.50. Anterior pronotal lobe globose; lateral margins rounded and strongly convex; anterior margin with a distinct band-like collar. Transverse pronotal impression complete and well demarked. Posterior pronotal margin straight across base of scutellum. Humeral angles truncate. Length anterior pronotal lobe 0.60; width 0.92; width transverse impression 0.88; length posterior pronotal lobe 0.58; width across humeral angles 1.50. Length scutellum 0.82; width 0.68. Hemelytra not quite attaining posterior end of abdomen; rounded rim of pygophore just barely visible beyond apex of membrane. Lateral corial margins sinuate at level of scutellar apex. Length corium 2.54; midline distance apex corium to apex membrane 0.84; length claval commissure 0.54; midline distance apex clavus to apex corium 1.08. Labium attaining mesocoxae. Length labial segments I 0.74, II 0.80, III 0.62 and IV 0.40. Bucculae short, projecting anteriorly around base of labium; buccular juncture broadly V-shaped and occurring close to base of labium. Antennae slender with segment IV fusiform and curving slightly. Length antennal segments I 0.50, II 0.96, III 0.86 and IV 1.10 (the right antenna oligomeric with only three segments). Total length 5.68.

**Holotype.** **Brazil:** 1♂, Rio de Janeiro, Silva Jardim, VIII-1974, F. M. Oliveira (AMNH). This new species is described from a single specimen, which was previously included as a paratype of *D. ocellatus* Brailovsky, but is clearly not conspecific with the holotype of *D. ocellatus*.

**Etymology.** I name this species for my colleague Dr. Peter D. Ashlock in appreciation for the many interesting specimens and moral support he has lent me over the years and for useful interactions and systematic advice which he has given very freely.



*Dushinckanus inermibus* (Distant), **New Combination**

*Myodocha inermiba* Distant, 1882:204.

**Discussion.** This striking species was described by Distant (1882) from a single specimen. Distant's description and dorsal view illustration allow identification of this species, which can also be recognized by characters included in the preceding key. The orange color of antennal segment II and the yellow band on the otherwise darker posterior pronotal lobe are quite distinctive. In general, this species has the same body form and surface texture indicated in the new species descriptions of this paper, being closest, as the key indicates to *D. camelopardus*.

**Material examined.** **Panama:** 1♀, Cerro Campana, 800 m R. de Pan, 8°40'N, 79°56'W, 27-VIII-1972, Engleman (PDA); 1♂, Bugaba, Champion (BMNH). **Costa Rica:** 1♀, Puntarenas Prov., Osa Peninsula, 2.5 mi SW Rincon, 08°42'N, 83°29'W, 1, 2-III-1969, leaf litter at night, K. Edwards (PDA).

**Variation.** The specimens examined are consistent with the original description, except that each has a small oval white macula in the center of the hemelytral membrane just behind the darkened anterior one-half, a feature possibly overlooked by Distant (1882). I have previously compared the Champion collected Bugaba, Panama specimen with the lectotype in the British Museum. This specimen is lighter and more orange in general coloration than the other two specimens examined in this study, but the basic color pattern does not vary among the three specimens.

***Dushinckanus camelopardus*, new species****Fig. 1A**

**Description.** Head, anterior pronotal lobe, basal one-half of scutellum, and most of pleural and sternal surfaces of pro- and mesothorax blackish brown. Large macula on proximal one-half of hemelytral membrane and finger-like projections beyond it in distal portion of membrane between chestnut and blackish brown. Metapleura and metasterna, coxae and tibiae distally of all legs, forefemora, distal one-half of meso- and metafemora, apical one-half of scutellum, antennal segments I, III and IV as well as all but extreme distal portion of II, labium and majority of ventral surface of abdomen dark chestnut. Posterior pronotal lobe and clavus and corium along suture between them light chestnut. Four large elongate spots with imprecise borders distributed evenly across anterior one-half of posterior pronotal lobe and background color of clavus and corium tawny. A broad, irregular, transverse fascia preapically on corium, slender macula in narrow chestnut area of corium adjacent to clavus and curving vein demarking the proximomedial edge of dark membranal macula pale, sordid cream. Background color of membrane pale fuscous, contrasting with pale curving vein, dark distal veins and large dark macula. Distal end of antennal segment II, tarsi, and proximal one-half of meso- and metafemora pale, between buffy yellow and buffy brown. Lobe on rim of metathoracic scent gland auricle between brownish red and tawny.

Antennae, legs and labium smooth and impunctate. Antennae with numerous short, recumbent, distally directed hairs. Legs and labium with hairs slightly longer and less numerous. Tibiae of all three pairs of legs also bearing slender spine-like bristles. Head with numerous minute, anastomosing punctures giving a rugose or

roughened appearance and covered with many anteriorly directed recumbent hairs, except on prominent tylus which is largely devoid of hairs, impunctate and shining. Anterior pronotal lobe, save collar, impunctate. Collar of anterior pronotal lobe, posterior pronotal lobe, scutellum, clavus and corium with scattered punctures; scutellar punctures on apical one-half dense on either side of the stem of a broad impunctate Y-shaped carina. Dorsal body surface, other than that of head, dull with a gray pruinosity and with a few minute hairs restricted to punctures; pruinosity on anterior pronotal lobe very dense and forming a pattern with that on calli less dense so that calli appear as a pair of large dark patches separated by a median line of heavier pruinosity. Pleural and sternal portions of thorax largely pruinose, with few scattered punctures. Mesosternum with a pair of shining patches on either side of midline. Lobe of metathoracic scent gland auricle shining as well as contrasting in color. A rugose evaporative area around scent gland auricle covering metepisternum at least half way to hemelytral edge; this same texture present on mesepimeron and extending as a thin line along full length of meso-metapleural suture. Abdomen ventrally subshining, with numerous fine recumbent hairs and an irregular light-scattering texture.

Head gradually constricted postocularly to form a slender stalk-like neck (Fig. 1a). Vertex somewhat depressed before prominent, tuberculate, anterolaterally directed ocelli which lie just at level of hind margin of eyes. Juga carinate. Tylus prominent, somewhat elongate, and reaching to midlength of antennal segment I. Eyes protruding and suboval. Length of head 2.10; postocular length 0.88; width across eyes 1.22; interocular distance 0.48. Anterior pronotal lobe with rounded lateral margins directed gradually anteromesad toward a distinct anterior collar. Transverse pronotal impression complete but shallow and not strongly demarked. Posterior margin of posterior pronotal lobe straight across base of scutellum. Humeral angles rounded. Length anterior pronotal lobe 0.90; width 1.14; width transverse pronotal impression 1.12; length posterior pronotal lobe 0.70; width across humeral angles 1.80. Length scutellum 1.12; width 0.92. Hemelytra not quite attaining end of abdomen. Lateral corial margins sinuate at level of claval commissure. Length corium 3.40; midline distance apex corium to apex membrane 1.36; length claval commissure 0.72; midline distance apex clavus to apex corium 1.52. Lateral margins of last abdominal segment ending in a pair of small acute spines. Posterior ends of last connexival segment similarly spined on each side. Labium attaining mesocoxae. Length labial segments I 1.28, II 1.30, III 0.90 and IV 0.50. Bucculae short and rounded, directed anteriorly around base of labium; buccular juncture broadly V-shaped and occurring close to base of labium. Antennae slender with segment IV slightly curving. Length antennal segments I 0.90, II 1.62, III 1.52 and IV 1.50. Total length 8.52.

*Holotype*. Ecuador: 1♀, Coca, Mayo -65, L. F. Pena (BNMNH).

*Etymology*. Of the species known to date, *D. camelopardus* has the longest neck. I have no doubt that *Myodocha* and *Dushinckanus* are distinct genera and should remain recognized as such. However, to preclude any possibility of future homonymy with *Myodocha giraffa*, this new species has been given the species epithet of *camelopardus*, a synonym for the vertebrate giraffe.

A single female specimen of what is apparently a seventh species was examined from the American Museum of Natural History. Unfortunately, the specimen lacked locality data. Thus, since not even a country was indicated for locality (the label

reads only "28-III"), I have refrained from formally describing this species. It is apparently the sister species of *D. camelopardus* from which it differs by having the fourth antennal segment with a broad, pale annulus and the lateral margins of the anterior pronotal lobe more convex.

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**STOBAERA CONCINNA (HOMOPTERA: DELPHACIDAE):  
FIELD BIOLOGY, LABORATORY REARING AND  
DESCRIPTIONS OF IMMATURE STAGES<sup>1</sup>**

PAUL D. CALVERT<sup>1</sup>, STEPHEN W. WILSON<sup>2</sup>, AND JAMES H. TSAI<sup>3</sup>

<sup>1,3</sup>Fort Lauderdale Research and Education Center, IFAS, University of Florida,  
Ft. Lauderdale, Florida 33314 and

<sup>2</sup>Department of Biology, Central Missouri State University,  
Warrensburg, Missouri 64093

**Abstract.**—The biology of *Stobaera concinna* (Stål) was studied in south Florida from 1 June 1985 to 1 February 1986; it was reared in the laboratory and the immature stages described. *Stobaera concinna* feeds and reproduces on *Ambrosia artemisiifolia* L. and is polyvoltine. Field collected adults were returned to the laboratory and allowed to lay eggs on potted *A. artemisiifolia*. Upon emergence nymphs were separated and reared to adults. Durations of the five nymphal stadia were 4.57, 3.72, 4.00, 4.45, and 6.50 days, respectively. Nymphal instars differed in body size, number of pitlike sensoria, development of wingpads, number of metatibial and metatarsal spines, and shape and dentition of the metatibial spur.

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Little is known about the biology of the 11 species of *Stobaera*. In his revision of the genus, Kramer (1973) included distributional and host plant data and noted that adults and nymphs were collected primarily from *Ambrosia* spp. (ragweeds); their possible role in the biological control of these noxious weeds has not been investigated. In studies of the insect fauna of 8 species of ragweeds, Goeden and Ricker (1974a, b, 1975, 1976a, b, c) provided host plant records for several species of *Stobaera*. Reimer and Goeden (1981, 1982) described the immature stages of *Stobaera tricarinata* (Say), the most widely encountered species, and outlined the life history on its host, western ragweed (*Ambrosia psilostachya* DeCandolle).

*Stobaera concinna* (Stål) has been reported from most of southern North America, including Arizona, California, Colorado, Florida, Louisiana, Texas, Utah, and Mexico as well as the West Indies (Kramer, 1973). It has been recorded from *A. concertiflora* DeCandolle and *A. psilostachya* DeCandolle (Kramer, 1973; Goeden and Ricker, 1975, 1976c). Kramer (1973) suggested that *A. concertiflora* is the principal host with *A. psilostachya* serving as an alternate host or food plant. Neither of these ragweeds occurs in south Florida; however, *S. concinna* is present and abundant on *A. artemisiifolia* L.

The present study summarizes the biology of *S. concinna* and its relationship with *A. artemisiifolia* L. in south Florida, and includes information on laboratory rearing, descriptions and illustrations of immature stages and a key to nymphal instars.

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## MATERIALS AND METHODS

*Field and laboratory studies.* Field and laboratory studies were conducted at the Ft. Lauderdale Research and Education Center, Ft. Lauderdale, Florida. Sweep net samples (100 sweeps/week) were taken weekly in a pure stand of *Ambrosia artemisiifolia* L., ca. 20 × 30 m, from 1 June to 10 September 1985. After 10 September, weekly observations of *S. concinna* on individual plants continued through 1 February 1986. The information recorded included the number of adults and immatures collected, feeding sites, and oviposition sites. Adults were returned to the laboratory and placed on *A. artemisiifolia* plants grown in 15.2 cm diam. pots at 26.7°C and 12L:12D photoperiod and allowed to lay eggs. Cylindrical butyrate cages (Tsai, 1975) were used to keep insects on the host plants. Upon hatching the immatures were removed from the plant and placed in 2.5 cm diam. culture tubes containing a fresh *A. artemisiifolia* leaf and stem. The culture tube opening was covered with Parafilm® to prevent escape and desiccation. Plant tissue was replaced every 3 days or when required. Dead insects were replaced to obtain adequate numbers completing each molt. Daily observations of nymphs were made and dates of molts recorded.

*Descriptions of immatures.* The descriptions and illustrations of the egg and each nymphal instar and a key to nymphal instars are based upon laboratory reared individuals.

The 5th instar is described in detail but only major differences are described for 4th through 1st instars. Measurements are given in mm as mean ± SD. Length was measured from apex of vertex to apex of abdomen, width across the widest part of the body, and thoracic length along the midline from the anterior margin of the pronotum to the posterior margin of the metanotum. Eggs were obtained by removing them from host plants by inserting a needle under each egg and teasing it free.

## RESULTS AND DISCUSSION

*Field study.* Six hundred and seventy-three adults were collected throughout the study, and consisted of 72% of all *S. concinna* collected. Immatures were found from 13 June to 25 July and again from 9 August to 1 February 1986. *S. concinna* is polyvoltine with eggs laid continuously throughout the study. First and 5th instar nymphs were collected simultaneously due to the overlapping of generations.

As ragweeds began dying in early September, *S. concinna* numbers decreased slightly. However, as ragweed seedlings began appearing *S. concinna* numbers began to increase.

Adults and 4th and 5th nymphal instars were observed feeding on small to medium sized stems. First, 2nd, and 3rd nymphal instars fed on small leaf veins or midribs on the underside of leaves. Reimer and Goeden (1982) found similar feeding habits in *S. tricarinata* with 1st and 2nd instars feeding on the under surface of leaves on small veins and 3rd, 4th, and 5th instars feeding on stems.

Eggs were inserted singly in transverse rows of 3 to 5 eggs in small stems. Upon emergence, nymphs would walk to the nearest leaf to begin feeding.

*Laboratory study.* The duration of nymphal development was ( $\bar{x} \pm \text{SD}$ ) 23.4 ± 2.16 days. High mortality (75%) of 4th and 5th instar nymphs occurred early in the study but decreased when nymphs were provided with larger sections of ragweed

Table 1. Duration (in days) of the nymphal instars of *S. concinna*.

Nymphal instar	No. beginning	No. completing	Days	
			Range	Mean $\pm$ SD
1st	23	21	3-7	4.57 $\pm$ 1.03
2nd	29	25	3-5	3.72 $\pm$ 0.68
3rd	29	20	3-7	4.00 $\pm$ 1.17
4th	38	26	3-6	4.45 $\pm$ 1.05
5th	35	20	5-9	6.50 $\pm$ 1.28

stems and when stems were changed daily. Duration of the nymphal stadia are given in Table 1.

### *Descriptions of Nymphal Instars*

*Fifth instar* (Fig. 1). Length  $2.16 \pm 0.267$ ; thoracic length  $0.79 \pm 0.089$ ; width  $1.11 \pm 0.137$ .  $N = 20$ .

Form elongate, subcylindrical, slightly flattened dorsoventrally, widest across mesothoracic wingpads. Body mottled dark brown and cream, legs pale with dark brown transverse bands.

Vertex quadrate, length ca.  $0.75 \times$  width at base, posterior margin almost straight; carina on each side extending anteromedially from posterolateral corner and continuing onto frons as inner carina. Frons subrectangular; widest in upper  $\frac{1}{3}$ , width ca.  $0.8 \times$  length; carinate lateral margins convex, these outer carinae extending from vertex to near clypeal border and paralleled by pair of inner carinae; 9 pits between each inner and outer carina and 4 pits between each outer carina and eye. Gena with longitudinal row of 3 small pits. Clypeus narrowing distally, consisting of subconical basal postclypeus and cylindrical distal anteclypeus. Beak 3-segmented, segment 1 obscured by anteclypeus, lengths of segments 2 and 3 subequal; apex of segment 3 black. Eyes reddish. Antennae 3-segmented; scape slightly flattened anteroventrally; pedicel subcylindrical, ca.  $2 \times$  length of scape, with ca. 12-14 pitlike sensoria; flagellum bulbous basally, with elongate, bristle-like extension distally, bulbous base ca.  $0.2 \times$  length of pedicel.

Thoracic nota divided by middorsal line into three pairs of plates. Pronotal plates subrectangular, appearing triangular in dorsal view; anterior margin following posterior border of eye, posterior border sinuate; each plate with oblique posterolaterally directed carina originating on anterior margin in median  $\frac{1}{3}$  and terminating in middle of plate, carina bordered along inner margin by row of 7 pits extending posterolaterally to lateral border of plate (lateralmost pits not visible in dorsal view). Mesonotal median length ca.  $1.5-2 \times$  that of pronotum; subrectangular; each plate bearing an elongate lobate wingpad extending to, or nearly to, tip of metanotal wingpad; with posterolaterally directed carina originating on anterior margin in median  $\frac{1}{4}$  and terminating on posterior margin; 2 pits on either side of carina and 3 pits in lateral  $\frac{1}{3}$ . Metanotal median length ca.  $0.75 \times$  that of mesonotum; each plate bearing an elongate lobate wingpad extending to 4th tergite; with longitudinal carina originating

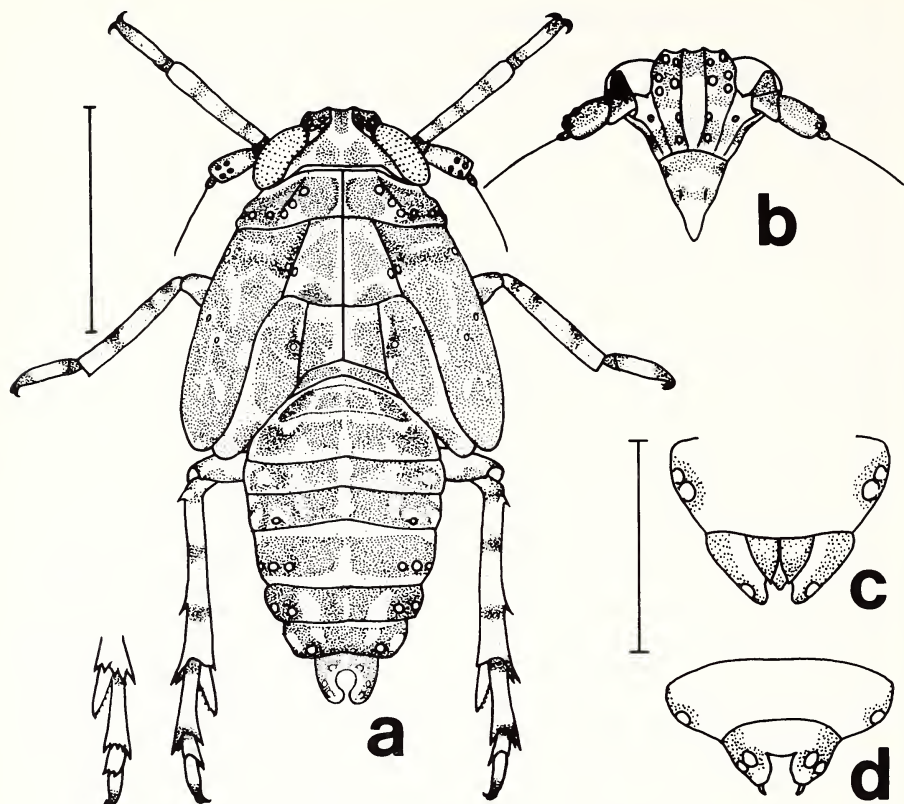


Fig. 1. *S. concinna* fifth instar. A. Habitus. B. Frontal view of head. C. Apical part of venter of female abdomen. D. Apical part of venter of male abdomen. Vertical bar = 1.0 mm.

on anterior margin in median  $\frac{1}{4}$  and terminating on posterior margin; 1 pit just lateral to carina. Pro- and mesocoxae elongate, posteromedially directed; metacoxae fused to sternum. Metatrochanter subcylindrical, with row of 15 minute teeth on posteromedial aspect. Metatibia with 2 black-tipped spines on lateral aspect of shaft, an apical transverse row of 5 black-tipped spines on plantar surface and a subtriangular, flattened movable spur with a row of 5-7 teeth on lateral aspect. Pro- and mesotarsi with 2 tarsomeres; tarsomere 1 wedge-shaped; tarsomere 2 subconical, curved, and with pair of apical claws and median membranous pulvillus. Metatarsi with 3 tarsomeres; tarsomere 1 cylindrical with apical transverse row of 6 black-tipped spines on plantar surface; tarsomere 2 cylindrical, with apical transverse row of 3 black-tipped spines on plantar surface; tarsomere 3 subconical similar to terminal tarsomere of other legs.

Abdomen 9-segmented; slightly flattened dorsoventrally, widest across segment 4 or 5. Tergite 1 reduced, tergites 5-8 each with 3 pits on either side of midline

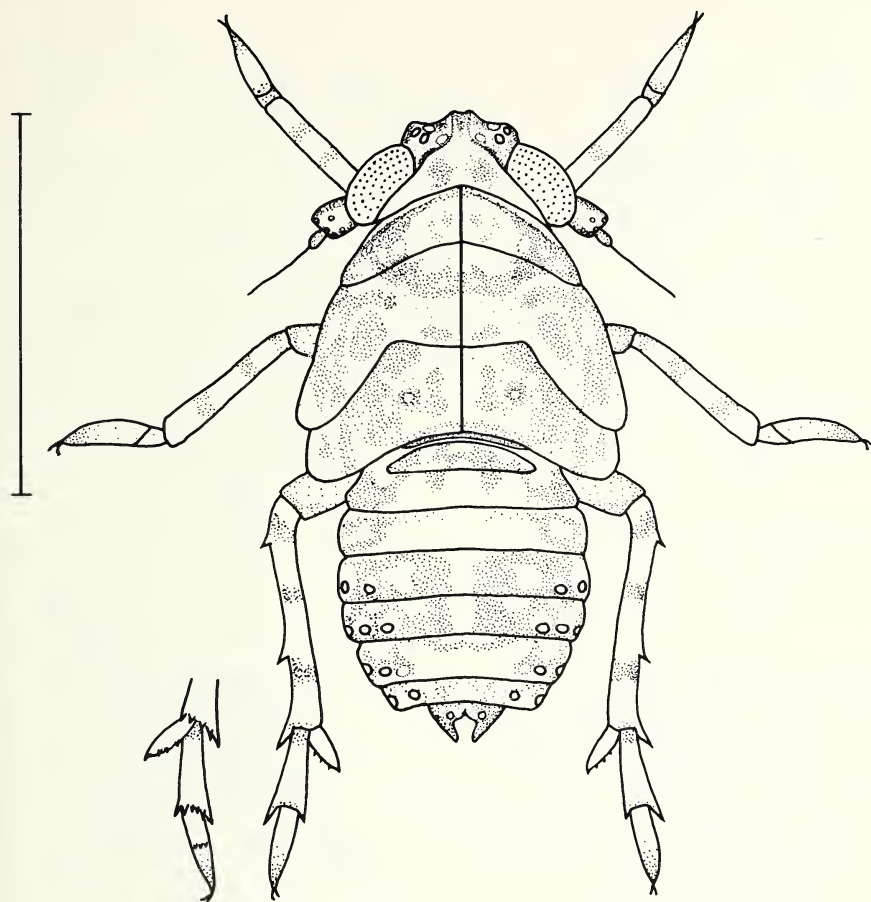


Fig. 2. *S. concinna* fourth instar. Vertical bar = 1.0 mm.

(lateralmost pits not always visible in dorsal view due to curving of tergites onto ventral aspect). Segment 9 surrounding anus; with 3 pits on each side; female with 1 pair of acute processes extending caudally from juncture of sternites 8 and 9; males lacking processes.

*Fourth instar* (Fig. 2). Length  $1.83 \pm 0.195$ ; thoracic length  $0.67 \pm 0.083$ ; width  $0.87 \pm 0.120$ .  $N = 17$ .

Frons with fewer pits between each outer carina and eye. Antennal pedicel with 6–8 sensoria.

Mesonotal wingpad  $\frac{2}{3}$  length of metanotal wingpad. Metanotal wingpad extending to 3rd tergite. Metatibial spur slightly smaller with row of 4 teeth on lateral aspect. Metatarsi with 2 tarsomeres; tarsomere 2 subconical with 3 black-tipped spines in median portion of tarsomere on plantar surface.



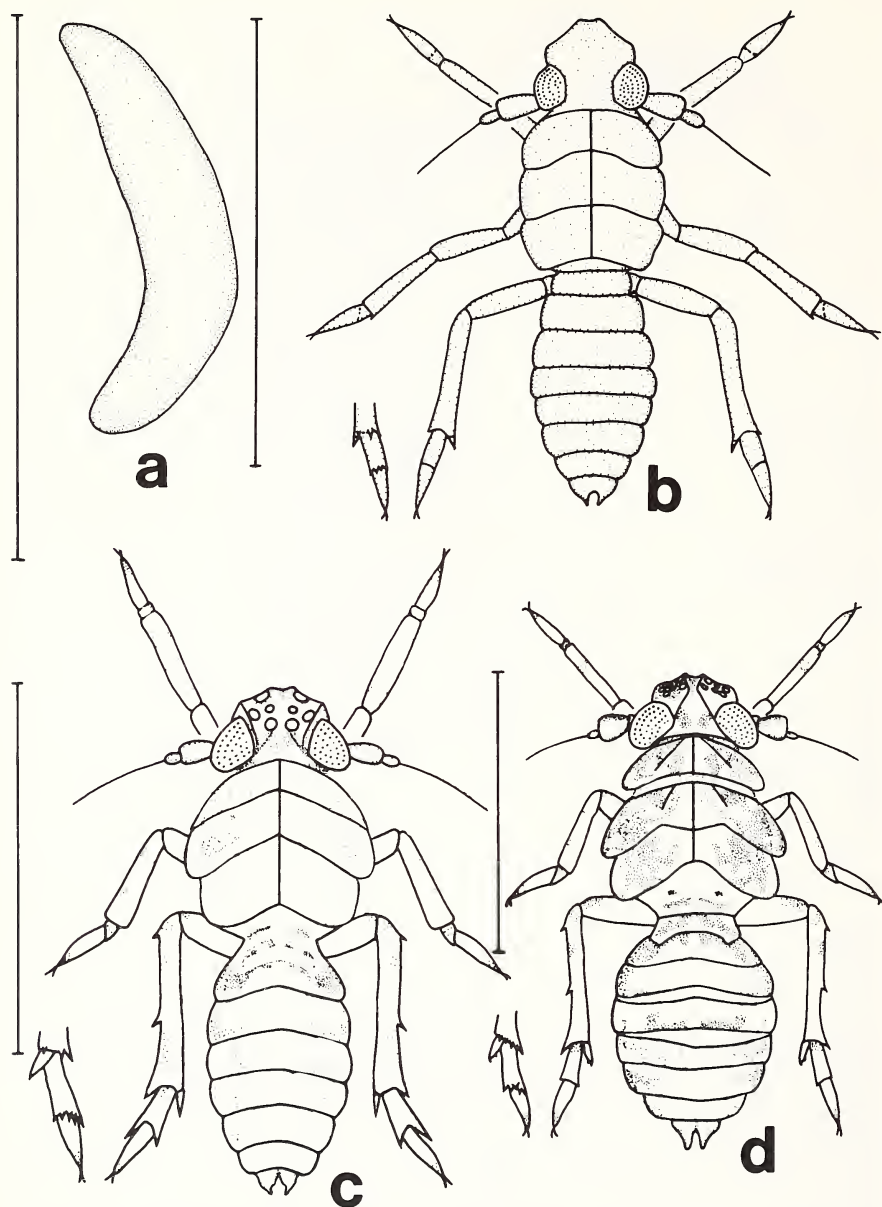


Fig. 3. *S. concinna* immature stages. A. Egg. B. First instar. C. Second instar. D. Third instar. Vertical bar = 1.0 mm.

*Third instar* (Fig. 3d). Length  $1.62 \pm 0.082$ ; thoracic length  $0.55 \pm 0.035$ ; width  $0.70 \pm 0.056$ .  $N = 12$ .

Antennal pedicel with 4–6 sensoria; bulbous base of flagellum ca.  $\frac{1}{2} \times$  length of pedicel.

Mesonotal wingpad shorter, covering  $\frac{1}{3}$  of metanotal wingpad laterally. Metatibial spur smaller; 2 teeth on margin. Metatarsomere 1 with apical transverse row of 5 black-tipped spines on plantar surface; tarsomere 2 without spines in middle.

*Second instar* (Fig. 3c). Length  $1.38 \pm 0.062$ , thoracic length  $0.45 \pm 0.022$ ; width  $0.45 \pm 0.048$ .  $N = 15$ .

Antennal pedicel with 2 sensoria. Meso- and metanotal wingpads undeveloped. Metatibia with apical transverse row of 4 black-tipped spines on plantar surface; spur smaller lacking lateral teeth, with black tipped tooth at apex.

Abdominal tergites with pits very obscure, tergite 5 with fewer pits and 6–8 each with 3 pits on either side of midline (lateralmost pits not visible in dorsal view due to curving of tergites onto ventral aspect).

*First instar* (Fig. 3b). Length  $0.97 \pm 0.115$ ; thoracic length  $0.34 \pm 0.055$ ; width  $0.29 \pm 0.026$ .  $N = 20$ .

Mottling absent or nearly so, body cream colored. Antennal pedicel lacking sensoria. Metatibia lacking spines on shaft; spur greatly reduced, slightly longer than longest metatibial spine, with black-tipped tooth at apex.

*Egg* (Fig. 3a). Length  $0.82 \pm 0.015$ , width  $0.15 \pm 0.017$ .  $N = 7$ . Eggs laid singly; white; cylindrical; chorion translucent, smooth.

Reimer and Goeden (1981) noted that first instar *S. tricarinata* lacked a metatibial spur, this is present in all other first instar delphacids examined (for example *Stenocranus lautus* Van Duzee, *Megamelus davisii* Van Duzee, *Pissonotus delicatus* Van Duzee, *Delphacodes idonea* Beamer, and *D. bellicosa* Muir and Giffard) (Calvert, Tsai, and Wilson, unpubl. data; Calvert and Wilson, 1986; Wilson, 1985; Wilson and McPherson, 1981); however, as the spur is very small it is difficult to find. They also reported a different arrangement of the 9 pits on the frons of the 5th instar; the arrangement found for *S. concinna* is similar to that reported for European delphacids by Vibaste (1968).

#### Key to *S. concinna* Nymphal Instars

1. Metatibial spur with marginal teeth; more than 3 pit-like sensoria present on antennal pedicel (Figs. 1, 2, 3D) ..... 2
- Metatibial spur without marginal teeth; antennal pedicel with 2 or fewer pit-like sensoria (Fig. 3B, C) ..... 4
2. Metatarsi with 3 tarsomeres; mesonotal wingpads extending to or almost to apex of metanotal wingpads (Fig. 1) ..... 5th instar
- Metatarsi with 2 tarsomeres (tarsomere 2 may be partially subdivided); mesonotal wingpads not extending to apex of metanotal wingpads (Figs. 2, 3D) ..... 3
3. Metatarsomere 2 with 3 small spines in middle; mesonotal wingpads covering ca.  $\frac{2}{3}$  of metanotal wingpads (Fig. 2) ..... 4th instar
- Metatarsomere 2 without spines; mesonotal wingpads covering less than  $\frac{2}{3}$  of metanotal wingpads (Fig. 3D) ..... 3rd instar
4. Metatibia with 2 spines on shaft; antennal pedicel with 2 pit-like sensoria (Fig. 3C) ... 2nd instar

- Metatibia apparently lacking spines on shaft; antennal pedicel lacking pit-like sensoria (Fig. 3B) ..... 1st instar

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**AMERICABRYA, A NEW GENUS OF ENTOMOBRYIDAE  
(COLLEMBOLA), WITH A REDESCRIPTION OF *A. ARIDA*  
(CHRISTIANSON AND BELLINGER) BASED ON MEXICAN  
SPECIMENS AND DESCRIPTIVE NOTES FOR  
*A. EPIPHYTA* (LORING)**

JOSÉ A. MARI MUTT AND JOSÉ G. PALACIOS-VARGAS  
Departamento de Biología, Universidad de Puerto Rico,  
Mayagüez, Puerto Rico 00708 and  
Laboratorio de Acarología, Departamento de Biología,  
Universidad Nacional Autónoma de México,  
04510 México, D.F.

*Abstract.* — The new genus *Americabrya* is proposed for the three New World species formerly placed in *Janetschekbrya* Yosii. This taxon is differentiated from *Janetschekbrya* by scale structure and its less abundant head and body macrochaetotaxy. *Americabrya arida* is reported for the first time from Mexico and is redescribed. Although the various Mexican populations of this species differ considerably in pigmentation and may belong to several species, no consistent morphological differences were detected between them, or with paratypes of *A. arida*. A few complementary notes to the original description of *A. epiphyta* are given based on a specimen from Peru. A key to the species of *Americabrya* is included.

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The genus *Janetschekbrya* was proposed by Yosii (1971) for two Himalayan species similar to members of the genera *Entomobrya* (subgenus *Himalanura*) and *Willowsia*. *Janetschekbrya* differed from the first genus by the presence of scales and from the second by the very different scale morphology.

*Janetschekbrya* was first reported from the New World by Palacios-Vargas (1979), but the first American species was described by Christiansen and Bellinger (1980), who erected *J. arida* for specimens collected in three localities in Arizona, New Mexico and Texas (southwestern United States). These authors noted that the Himalayan species have a chaetotaxy very different from that of *J. arida* and that there is also a marked difference in scale structure. They suspected that Yosii's species and *J. arida* were not closely related, but chose not to erect a new taxon for their species.

The second New World *Janetschekbrya* was described by Snider (1981) from specimens collected in Costa Rica. This author remarked that his species did "not exactly fit the genus as described by Yosii" but preferred not to erect a new genus until additional species were discovered. Loring (1984) described *J. epiphyta* from Peru and also commented on the similarities between the New World species compared with those from Himalaya. Loring stated "Further examination of these species (New World) is necessary because the Asian and American species may belong to different genera, particularly in light of their known distribution."

Our analysis of the literature and of specimens from the United States, Mexico, Nicaragua and Peru convinced us that the American species of *Janetschekbrya* should be placed in a different genus, for which we propose the name *Americabrya*. This



taxon is probably widespread in the Neotropics but may have previously been undetected because its species are apparently more abundant in the vegetation than in leaf litter, which is the habitat most frequently sampled.

#### DESCRIPTIONS

##### **Americabrya**, new genus

Species formerly placed in *Janetschekbrya* which possess non-ciliated scales with two distinct longitudinal ribs (Figs. 6, 11). The new taxon also differs from *Janetschekbrya* by its less abundant head and body macrochaetotaxy and by the presence of smooth prelabral setae (ciliated in *Janetschekbrya*).

*Type species. Janetschekbrya arida* Christiansen and Bellinger, 1980.

##### *Americabrya arida* (Christiansen and Bellinger), **New Combination** Figs. 1–21, 26, 27

*Janetschekbrya arida* Christiansen and Bellinger, 1980:918–919, fig. 751A–H. Palacios-Vargas et al., 1982:141, as cf. *arida*.

*Janetschekbrya* sp. Palacios-Vargas, 1979:42. Palacios-Vargas, 1981:90.

It is with much apprehension that we place under this species all our Mexican material. Members of various populations, or single specimens from isolated populations, possess color patterns that differ markedly from that of typical *A. arida*. However, we have failed to detect a single consistent and reliable morphological difference between any of these populations, or between them and the paratypes of *A. arida* that we have studied.

All the specimens collected at 3,900 m on the Popocatepetl volcano present the color pattern shown in Figure 1 (form B). Individuals differ in the intensity of the pigment but even the lighter specimens possess the conspicuous, wide middorsal stripe that extends from the second thoracic segment to the third abdominal segment. At 3,000 m on the same volcano, the specimens are either completely pigmented (Fig. 2, form C) or have the thorax almost completely white (Fig. 3, form D). One specimen is white except for the eyes, antennae, venter of body and a light dorsolateral band on the third abdominal segment. Another individual is similar to form B but lacks pigment to the sides of the middorsal stripe.

The specimens from the other Mexican localities may be referred to forms C and D but the intensity of the pigment is usually reduced, sometimes until the animals appear uniformly light blue or almost white. Three exceptions are the specimens from Baja California, which possess a longitudinal band along the sides of the body and a dorsal transverse band on Abd. 3 (Figs. 8, 9, form E); a single specimen from Chalcatzingo, which has only a lateral longitudinal stripe on each side of the body (Fig. 7, form F); and the five specimens from Guerrero, which possess a pigmentation identical to that of typical *A. arida* (cf. Figs. 4, 5, form A). Our five specimens from Nicaragua are uniformly light blue.

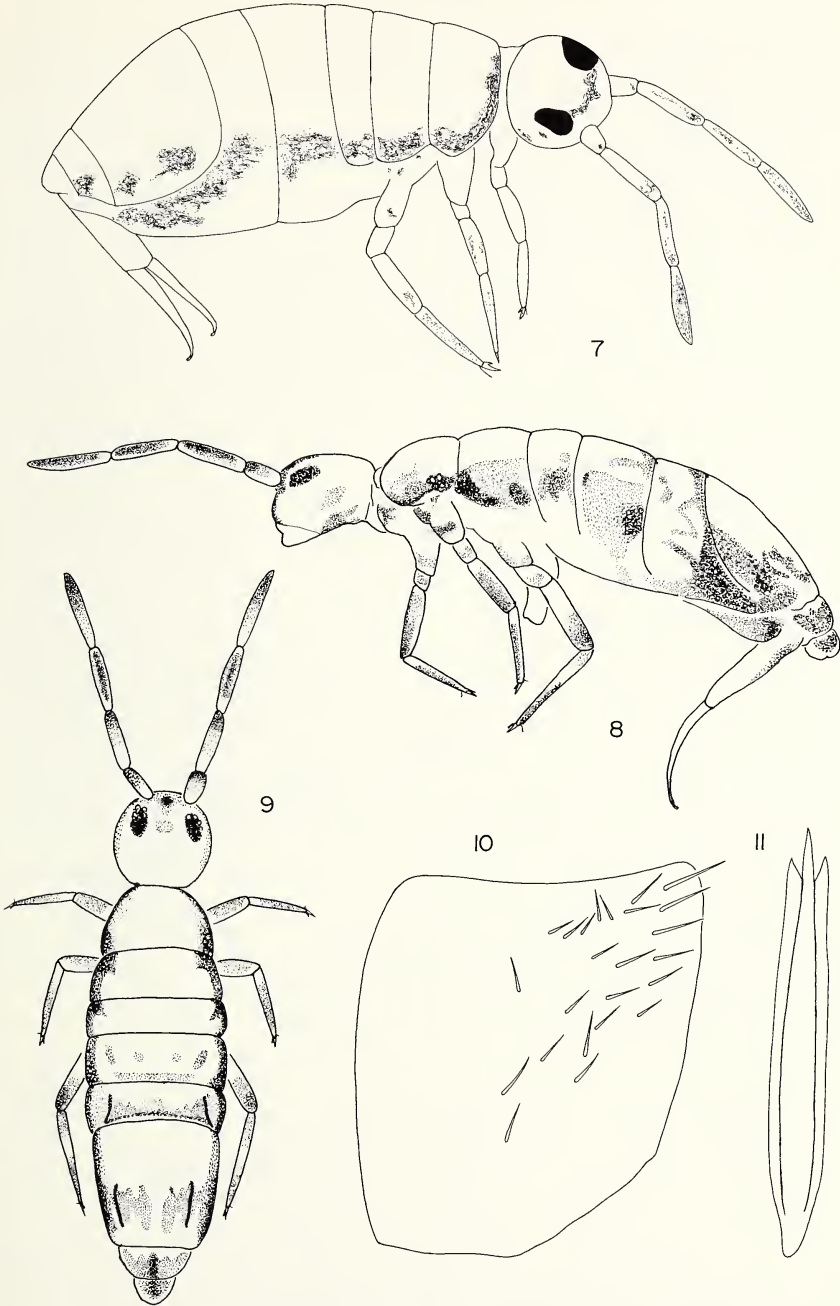
The following redescription of *A. arida* is based on 10 specimens from the Popocatepetl volcano (form B) but the morphological details apply to all the material listed after the description.



Figs. 1-3. *Americabrya arida*. 1. Form B. 2. Form C. 3. Form D.

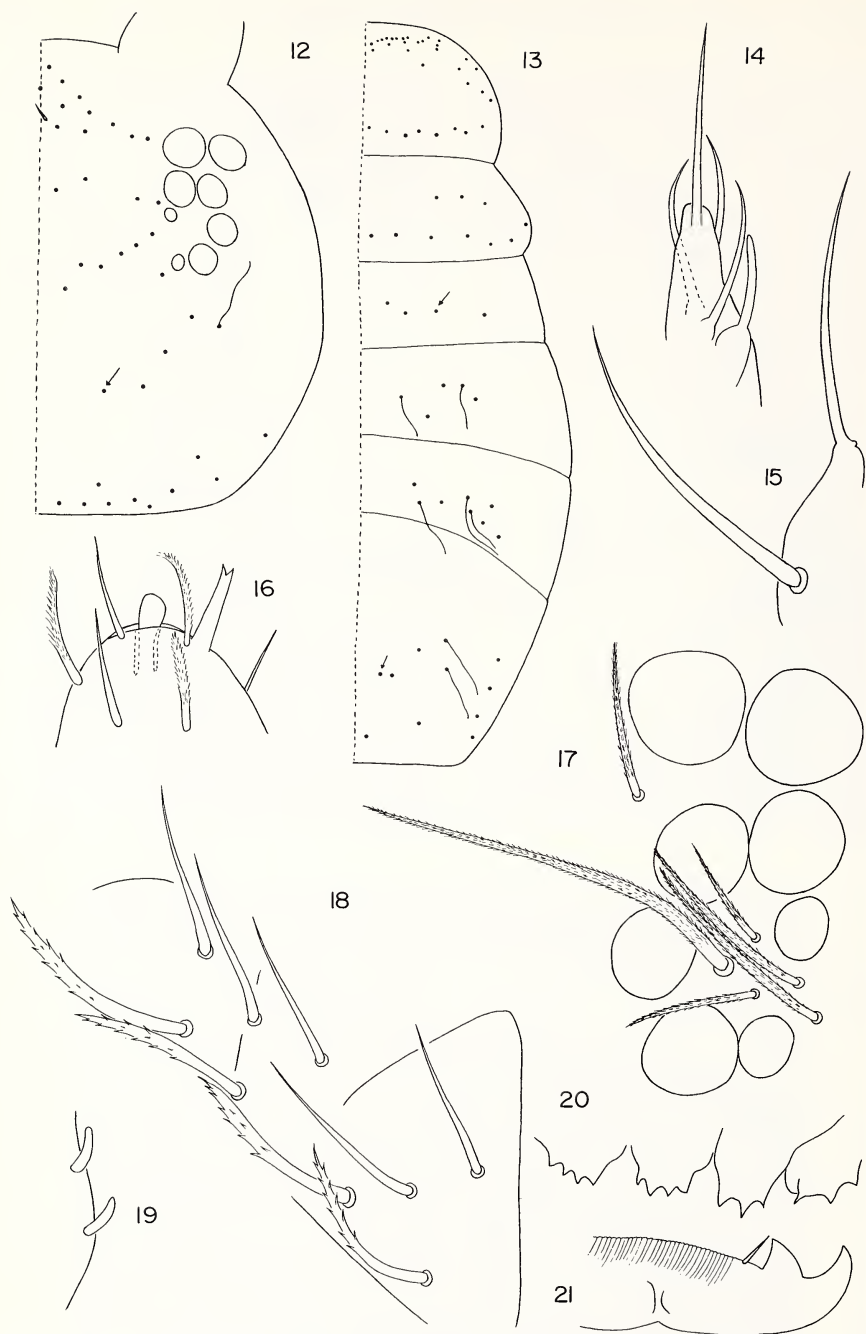


Figs. 4-6. *Americabrya arida*. 4. Form A, specimen from New Mexico. 5. Form A, specimen from Mexico (Guerrero). 6. Scales.



Figs. 7-11. *Americabrya arida*. 7. Form F. 8, 9. Form E. 10. Trochanteral organ. 11. Scale.





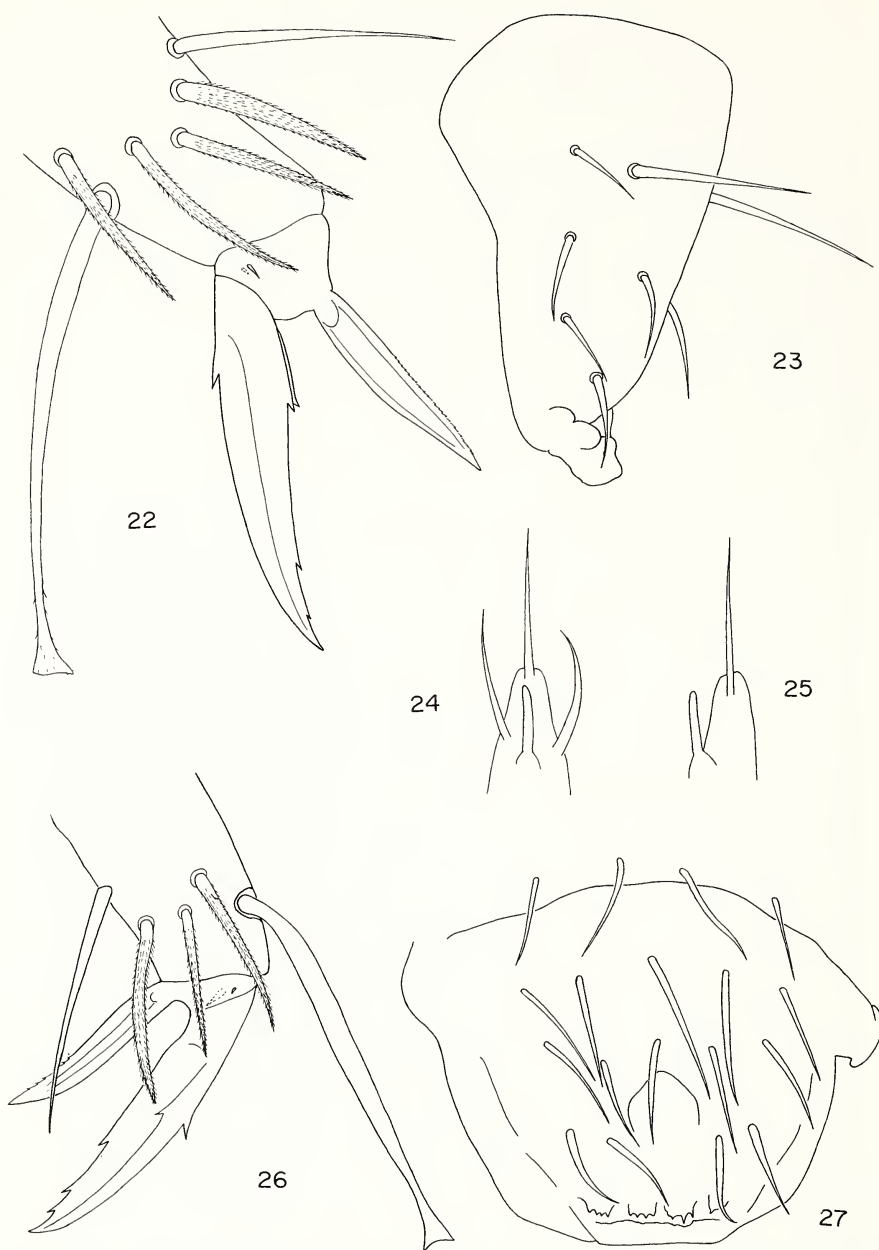
Figs. 12-21. *Americabrya arida*. 12. Distribution of head macrochaetae, arrow signals a seta that was absent on both sides of the head of one specimen. 13. Distribution of body macrochaetae, arrows signal setae that were absent on both sides of the body of one specimen. 14. Outer labial papilla. 15. Maxillary palp. 16. Apex of Ant. 4. 17. Eyes and distribution of interocular setae. 18. Labial chaetotaxy. 19. Sensillae on apex of Ant. 3. 20. Labral papillae. 21. Mucro.

Length to 2.45 mm. Intensity and distribution of violet pigment as in figure 1 (but see preceding discussion). Head and body with numerous ribbed scales that are absent from antennae, legs and abdominal appendages. Antennae  $2.4\times$  longer than head, relative lengths of segments: 1:2:2:2.3. Apex of Ant. 4 with a 2-pointed pin seta and a simple sensilla placed in a deep depression (Fig. 16). Sense organ of Ant. 3 of 2 simple exposed sensillae (Fig. 19). Head macrochaetotaxy and interocular chaetotaxy as in Figures 12 and 17. Prelabral and labral setae smooth (Fig. 27). Labral papillae large, each with 3–4 apical denticles (Fig. 20). Labial chaetotaxy follows formula a1–a5MEL1L2 (Fig. 18). Subapical seta of maxillary palp somewhat longer and thicker than apical seta (Fig. 15). Differentiated seta of outer labial papilla thick (Fig. 14), not reaching apex of its papilla. Along ventral cephalic groove 4+4 to 7+7 ciliated setae. Trochanteral organ with up to 24 setae (Fig. 10), usually 17. Unguis (Fig. 26) with 2 outer teeth and 4 conspicuous inner teeth. Unguiculus with one lightly serrated outer lamella. One pretarsal seta much larger than the other. Tenent hair thick and very long. Length of smooth seta opposite tenent hair of third pair of legs/length of unguiculus = 1.14 (1.03–1.35,  $N = 18$ ). Body macrochaetotaxy as in Figure 13. Anterior face of colophore with many ciliated setae, 2 apicals much longer than others. Tenaculum with a long, lightly ciliated seta. Dentes slightly longer than manubrium. Mucro with 2 teeth and basal spine (Fig. 21). Female genital plate with 2 smooth setae on each valve, male plate not seen (all specimens are female).

*Material examined* (collected by the junior author unless otherwise noted). **MEXICO.** **Mexico State:** Popocatepetl volcano, *Pinus hartwegii* forest, leaf litter, 3,900 m, 29.I.1983, 10 specimens on slides and 21 in alcohol. As preceding but collected in 1982, 79 in alcohol. Popocatepetl, *Pinus* sp. forest, leaf litter, 3,000 m, 2.I.1983, 7 on slides and 24 in alcohol. As preceding but collected on 4.III.1983, 2 in alcohol. **Morelos State:** Derrame del volcán Chichinautzin, on epiphytic *Tillandsia* (Bromeliaceae), 2,430 m, 14.III.1976, 5 on slides. As preceding but collected at 2,400 m, 22.XII.1976, 1 on slide. As preceding but taken at 2,275 m, 1 on slide. Morelos, Chalcatzingo, on rupicolous *Tillandsia*, 1,400 m, 3.X.1976, 1 on slide. Morelos, San Juan, Tepoztlan, leaf litter, 2,300 m, 12.XI.1978, C. Macías, 1 on slide. **Durango State:** La Michilía, Cañada de Taray, mixed pine forest, 2,350 m, leaf litter, J. G. Palacios-Vargas and J. Najt, 1 on slide. **Federal District:** Contreras, on mosses and leaf litter, 3,100 m, 28.XI.1976, 6 on slides. **Guerrero:** road from Taxco to Tetipac, km 7, on *Tillandsia prodigiosa*, 16.X.1976, 5 on slides. **Baja California:** Los Cabos municipality, Sierra de La Laguna, mixed pine forest, leaf litter, 9.IV.1983, M. M. Vázquez, 12 on slides and 60 in alcohol. All this Mexican material is deposited in the collections of the authors.

**UNITED STATES.** **Arizona:** Cochise County, 3,304, 3 paratypes on slides. **New Mexico:** Los Alamos, Tandel Canyon, 2–6.VI.1976, M. I. and D. C. Lowrie, 1 on slide. Los Alamos, Mortandad Canyon, 25–26.VI.1976, pitfall trap, 5,878, 3 on slides. One specimen from the third locality is at the Illinois Natural History Survey. The other specimens are in the collection of Dr. Kenneth Christiansen, Grinnell College, Iowa.

**NICARAGUA.** Road from Matagalpa to Jinotega, km. 150, *Pinus ocarpus* forest, light trap, 1,200–1,300 m, I–VIII.1984, J.-M. Maes, col., 5 on slides. Three specimens are in the collection of the junior author and two are in the collection of Dr. Jean-Michael Maes, Leon University, Nicaragua.



Figs. 22–27. *Americabrya epiphyta*. 22. Claws. 23. Lateral view of labrum. 24, 25. Outer labial papilla. 26, 27. *Americabrya arida*. 26. Claws. 27. Labrum.

*Americabrya epiphyta* (Loring), New Combination

Figs. 22–25

*Janetschekbrya epiphyta* Loring, 1984:563–564, figs. 1–12.

The observations reported below are based on a specimen from Peru that was damaged during mounting and did not permit us to observe all the details of the pigmentation and chaetotaxy. The other characters agree with the original description except that, according to Loring, the differentiated seta of the outer labial papilla extends beyond the apex of its papilla. His figure suggests that he mistook the differentiated seta for one of the regular setae on the papilla. Loring also states that the pretarsal setae are absent but such is not the case in our specimen.

Outer setae of first labral row about  $0.5 \times$  length of other setae on this row (Fig. 23). Labial chaetotaxy as in *A. arida*. Differentiated seta of outer labial papilla not reaching apex of its papilla (Figs. 24, 25). Along ventral cephalic groove  $3+3$  ciliated setae. Proximal third of tibiotarsus with a long, thick ciliated seta which clearly stands out from neighboring setae. One pretarsal setae much smaller than the other (Fig. 22).

*Material examined.* PERU, Rio Ampiyacu, Estirón, leaf litter from 30 year old secondary forest, XII.1983 and I.1984, C. Amedegnato and S. Poulain, 1 on slide.

KEY TO THE SPECIES OF *AMERICABRYA*

1. Unguiculus obliquely truncated; margins of scales serrated; body unpigmented except for a pair of very small spots on Abd. 3 and Abd. 5; Costa Rica ..... *A. matthewsi*
- Unguiculus lanceolate; margins of scales smooth; body usually with patterns of pigment ..... 2
2. Labral papillae without apical denticles; basal pair of ungual teeth placed close to base of unguis (Fig. 22); Peru ..... *A. epiphyta*
- Labral papillae with 2–4 apical denticles (Fig. 20); basal pair of ungual teeth placed near middle of unguis (Fig. 26); southwestern United States, Mexico, Nicaragua ..... *A. arida*

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**LECTOTYPE DESIGNATIONS FOR THE TICKS  
(ACARI: IXODOIDEA: IXODIDAE)  
DESCRIBED BY ASA FITCH**

JAMES E. KEIRANS AND JEFFREY K. BARNES

Department of Health and Human Services, Public Health Service, National  
Institutes of Health, National Institute of Allergy and Infectious Diseases,  
Department of Entomology, Museum Support Center,  
Smithsonian Institution, Washington, D.C. 20560 and  
Biological Survey, New York State Museum,  
The State Education Department, Albany, New York 12230

*Abstract.*—Dr. Asa Fitch, the first professional entomologist appointed by a state legislature, described three tick species and what he questionably believed to be a fourth. These specimens have been rediscovered, and lectotypes have been designated.

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Dr. Asa Fitch (1809–1879) was born in Salem, Washington County, New York, where he lived for most of his life. Although he was a physician by training, he was an entomologist by inclination, and he was even nicknamed “The Bug-Catcher” by his neighbors (Mallis, 1971). Fitch was not officially entitled to the name of State Entomologist of New York, although he was sometimes accorded that title, and from 1855 to 1872 he published fourteen reports on the noxious, beneficial, and other insects of the State of New York. In these reports and several other publications he described well over 400 arthropod species and subspecies, and he is especially well remembered for his work with Homoptera. In his fourteenth report (Fitch, 1872), he described three tick species, and questionably placed a fourth species in the genus *Ixodes*: 1) the five-lined tick, *I. quinquestriatus* (as “*I. 5-striatus*”), 2) Robertson’s tick, *I. robertsonii*, 3) the torturing tick, *Ixodes cruciarius*, and 4) the toothache mite, *Ixodes odontalgiae*.

Neumann (1911) synonymized both *I. quinquestriatus* and *I. robertsonii* with *Dermacentor variabilis* (Say, 1821) and *Ixodes cruciarius* with *I. cookei* Packard, 1869. Cooley (1938) followed Neumann in accepting the *Dermacentor* synonymies. Cooley and Kohls (1945) and Keirans and Clifford (1978) accepted the *Ixodes cruciarius* synonymy. Bequaert (1946) accepted all of Neumann’s synonyms.

It is known that Professor Cooley examined Fitch’s specimens of *Ixodes quinquestriatus* and *I. robertsonii*. We are in possession of Dr. Glen M. Kohls’ copy of Bequaert (1946) in which he wrote beside the entries for *I. quinquestriatus* and *I. robertsonii* (p. 165) “♀ [*quinquestriatus*], ♂ [*robertsonii*], on pin, seen by Cooley, March, 1939.” Kohls was Cooley’s coworker for many years. It appears that no one has seen any of Fitch’s tick specimens, which, along with all their associated collecting data, have been “lost” to science for the intervening 47 years.

Dr. Fitch never designed a type for any of his species. However, he did label nearly all of his specimens with individual numbers, which he recorded in four register books—two for specimens from New York State, one for specimens from elsewhere

in the United States and from Canada, and one for specimens from other parts of the world. The register books for specimens from the United States and Canada, including New York State, are in the New York State Museum, Albany, and the other book is in the library of the Museum of Science, Boston.

In his registers, next to the appropriate specimen numbers, Fitch recorded the species names and various collecting data, including dates and localities. He also recorded the numbers and dates in his extensive manuscript notes, most of which are in the possession of the New York State Museum. His specimen labels can be readily correlated with the register numbers, thus enabling the recognition of type series and the determination of localities and other data relating to the types (Barnes, 1984a, b). Having recognized the type series, it is possible to designate lectotypes. Keirans has had the opportunity to study Fitch's types of *I. quinquestriatus*, *I. robertsonii*, *I. cruciarius*, and *I. odontalgiae*. The specimen of the latter species (National Parasite Collection number 3477; Type No. 1346 USNM) is an immature spider and will not be mentioned further. Lectotypes and paralectotypic series have been designated and isolated within the vials and jars containing specimens of the taxa. The nomenclative status of this material is clearly indicated on an additional included label.

Many of Fitch's tick specimens were sent to his home in Salem, New York, by William Schenck Robertson, a pioneer educator at the Tullahassee Mission in Indian Territory (Dale, 1935). Fitch received thousands of arthropod specimens from Robertson, and he usually indicated in his registers and notes that they came from "Tullehassie, West of Arkansas" (=Tullahassee, Wagoner County, Oklahoma) and gave a date—presumably the one on which an individual lot of specimens was received.

At least one tick specimen sent by Robertson was recorded as having come from "Park Hill, bank of Illinois Creek—Aug. 13, 1852." These data seemed enigmatic until we discovered that in 1850 Robertson married Ann Eliza Worcester, the eldest child of Rev. Samuel A. Worcester, who had for some years been in charge of the Cherokee mission at Park Hill, Cherokee County, Oklahoma, less than 30 miles from Tullahassee (Dale, 1935).

*Ixodes quinquestriatus* Fitch, 1872:366

Junior subjective synonym of *Dermacentor variabilis* (Say, 1821).

There are two jars labelled "*Ixodes quinque-striatus*" as follows:

Jar #1 contains 3♀♀ *Dermacentor variabilis* as follows:

1) 1 *D. variabilis* on full pin; hand-written 2995 on white label on pin. 2) 1 *D. variabilis* on full pin; hand-written 1256 on white label on pin. 3) 1 *D. variabilis* on broken pin; no label. There are 3 free-floating labels in the alcohol: 1) *Ixodes 5-striatus*, Ark. W. S. Rob. [Hand-written]. 2) Fitch's Collection [Machine-printed]. 3) 5688 [Hand-written]. Presumably this label belongs to the ♀ *D. variabilis* on the broken pin.

The three ticks in this jar were given National Tick Collection number RML 118013 and National Parasite Collection number 3472.

Jar #2 contains 1♀ *Dermacentor variabilis* on a broken pin. There are 6 free-floating labels in the alcohol:

1) *Ixodes 5-striatus*, Va. T.A. Culb. [Hand-written]. 2) Fitch's Collection [Machine-printed]. 3) Fitch's Type [Machine-printed]. 4) Type No. 1348 U.S.N.M. [Machine-printed except for hand-written number]. 5) TYPE [Machine-printed]. 6) 744 [Hand-written].

This tick was given National Tick Collection number RML 118014 and National Parasite Collection number 3472.

*Types.* Lectotype ♀ (RML 118014; NPC 3472; USNM 1348; Fitch 744) *Ixodes quinquestriatus*, host unknown, Cartersville, Cumberland County, Virginia, received by Dr. Fitch in 1847 from Thaddeus A. Culbertson and 3♀♀ paralectotypes (RML 118013; NPC 3472; Fitch 2995, 1256, 5688), host unknown, Tullehassie, Indian Territory west of Arkansas (now Tullahassee, Wagoner County, Oklahoma) received by Dr. Fitch on Dec. 4, 1851 (2995), Jun. 19, 1851 (1256), and Jul. 1852 (5688) from William S. Robertson. All are deposited in the National Parasite Collection, U.S. Department of Agriculture, Beltsville, Maryland 20705, USA.

Fitch listed another specimen in his register and notes, his number 5760, with the same data as number 5688, but we have not located it.

*Ixodes robertsonii* Fitch, 1872:366

Junior subjective synonym of *Dermacentor variabilis* (Say, 1821).

In the jar are 2♂♂ *D. variabilis*, one on a full pin with an attached label with a hand-written number 6364. The second specimen is on a broken pin and on another piece of broken pin is a label with the hand-written number 1639. There are 4 free-floating labels in the alcohol:

1) *Ixodes robertsonii*, Fitch [Hand-written]. 2) Fitch's Collection [Machine-printed]. 3) TYPE [Machine-printed]. 4) Type No. 1351 U.S.N.M. [Machine-printed except for hand-written number].

*Types.* Lectotype ♂ (on full pin) (RML 118012; NPC 3475; USNM 1351; Fitch 6364), and 1♂ paralectotype (RML 118012; NPC 3475; USNM 1351; Fitch 1639) *Ixodes robertsonii*, host unknown, bank of Illinois Creek, Park Hill, Cherokee County, Oklahoma, Aug. 13, 1852, Rev. William S. Robertson. Collection data for lectotype from Fitch's manuscript notes and collection register; no collection data mentioned in his manuscript notes for the paralectotype (Fitch 1639). Both specimens deposited in the National Parasite Collection, U.S. Department of Agriculture, Beltsville, Maryland 20705, USA.

In addition to Fitch's tick species *I. robertsonii*, we also found in the National Tick Collection two ticks in a jar labelled *Ixodes robertsonii* var. o-----s. There are 6 free-floating labels in the alcohol:

1) *Ixodes* [specific epithet crossed out] var. o-----s, Ark. W.S. Rob. [Hand-written]. 2) Fitch's Collection [Machine-printed]. 3) Fitch's Type [Machine-printed]. 4) 2859 [Hand-written]. 5) Virtually unintelligible label bearing the remains of a number, perhaps 5597 [Hand-written]. 6) Type No. 1352 U.S.N.M. [Machine-printed except for hand-written number].

The two ticks, each with a pin hole, are 1♂ *Amblyomma maculatum* Koch and 1♂ *Amblyomma cajennense* (Fabricius). The collection has been given National Tick Collection number RML 118017; USNM 1352.

According to Fitch's specimen register, collection 2859 arrived at his home in New



York, Dec. 4, 1851, and was received from William S. Robertson, Tullehassie, W. of Arkansas. Evidently, Fitch was unsure whether these specimens constituted a new species or a variety of *I. robertsonii* and so published neither description nor name. Fitch's tick name is not recorded here because it would constitute a *nomen nudum*. Specimens deposited in the National Tick Collection, Museum Support Center, Smithsonian Institution, Washington, D.C. 20560, USA.

*Ixodes cruciarius* Fitch, 1872:366

Junior subjective synonym of *Ixodes cookei* Packard, 1869.

In the jar is 1 nymph of *Ixodes cookei* on a broken pin. There are 4 free-floating labels in the alcohol:

1) Fitch's Collection [Machine-printed]. 2) Fitch's Type [Machine-printed]. 3) Type No. 1347 U.S.N.M. [Machine-printed except for hand-written number]. 4) TYPE [Machine-printed].

*Type*. Lectotype nymph (RML 118015; NPC 3476; USNM 1347) *Ixodes cruciarius*, no collecting data with specimen, although the USNM Type catalogue lists the collection from New York. According to Fitch's published description and manuscript notes, he saw at least three specimens, including a very small one collected Sept. 8, 1857 "on Anna's [his daughter's] arm." That specimen is not numbered in Fitch's notes. His specimen number 15,669 was collected Nov. 1, 1868 from a mink, and his specimen number 15,670 was found in "1868 on Miss Turner's leg, in bed, by night." All 3 specimens were presumably collected at or near his home in Salem, New York. Lectotype deposited in the National Parasite Collection, U.S. Department of Agriculture, Beltsville, Maryland 20705, USA.

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We thank Dr. J. Ralph Lichtenfels, Curator, National Parasite Collection, U.S. Department of Agriculture, Beltsville, MD, for allowing JEK to study Asa Fitch's tick collection. Dr. Wayne N. Mathis and Mr. Richard G. Robbins, Department of Entomology, Smithsonian Institution, kindly reviewed the manuscript. Published in part as contribution number 485 of the New York State Science Service.

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**EXPERIMENTAL INDUCTION OF THE MYCOSIS CAUSED BY  
*ENTOMOPHTHORA MUSCAE* IN A POPULATION OF  
HOUSE FLIES (*MUSCA DOMESTICA*)  
WITHIN A POULTRY BUILDING**

JOHN PAUL KRAMER AND DONALD C. STEINKRAUS

Department of Entomology, Cornell University,  
Ithaca, New York 14853

**Abstract.**—Color-marked house flies (*Musca domestica*) with advanced infections of *Entomophthora muscae* were added to a test group of healthy young adult flies within a poultry building. About 6 to 8 days after the flies in the marked-infected group died, those in the test group also died. Cadavers of flies that succumbed to the infection were found on various surfaces within the building. This probably serves to promote the distribution of infective conidia within the general environment. Deaths attributable to the mycosis in the test group probably approached or reached 100%. It is suggested that *E. muscae* can be used to control house flies in the field.

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While spectacular natural epidemics of the mycosis caused by *Entomophthora muscae* in populations of *Musca domestica* have been reported in the literature for decades (see Greenberg, 1973; West and Peters, 1973), the exploitation of this fungus in the biological control of house flies has received little consideration. In the literature available to us we found only two previous studies that center on the use of *E. muscae* for house-fly control. Schweizer (1936) added small chunks of an *in vitro* culture of a fungus he identified as *E. muscae* to saucers of milk and sugar. These dishes were placed in stables, and the harmful effects on house flies were noticed within a short time. Unfortunately the methods he used to culture the fungus and to measure the impact of the contaminated sugar-milk on populations of flies are described only briefly. Vogel (1968) also cultured a fungus he identified as *E. muscae* on a special substrate. Pieces of fresh mycelium from these cultures set out in animal buildings were said to have caused rapid mortality within house-fly populations. How he conducted his field tests and measured his results is not given. Here we discuss our attempt to induce the fatal disease caused by *E. muscae* in a previously disease-free population of house flies under field conditions. The results not only contribute to our understanding of the epidemiology of the mycosis caused by *E. muscae*, but also clearly demonstrate that this fungus could be used to control house flies in the field.

**MATERIALS AND METHODS**

**The test site.** The poultry building selected for the experiment was one of eight similar structures (each about 4 m wide, 3 m deep and 2.5 m high) located on a sunny and well-drained field of closely mown grass at Cornell University's Poultry Research Farm 2, Ithaca, New York (Fig. 1). Large screened windows covered the upper portion of the front of the house. The rear wall was windowless. One side of

Table 1. The fate of marked-infected flies and test flies: the spatial distribution of their cadavers and the prevalence of *Entomophthora muscae* infections among them.

Sites	Marked-infected flies <sup>1</sup>		Test flies <sup>2</sup>	
	# (%)	% infected	# (%)	% infected
Floor	104 (53)	100	169 (49)	88
Feeder	57 (29)	100	38 (11)	100
Strings	28 (15)	100	85 (25)	93
Walls	5 (2)	100	38 (11)	100
Ceiling	3 (1)	100	12 (4)	100
Totals	197 (100)	—	342 (100)	—

<sup>1</sup> Excludes about 50 flies not recovered at end of test.

<sup>2</sup> Excludes about 100 flies not recovered at end of test.

the house was fitted with a large hinged door, while the other side contained but one small screened window. The floor was solid except for several small and inconspicuous holes, undoubtedly the handiwork of mice. Traces of chicken droppings, feathers, spilt chicken feed, cobwebs and dust covered parts of the walls and floor. This refuse was removed to maximize our chances for successfully following the fate of the flies used in this study. We also felt that a relatively clean building might discourage the activities of Canadian deer mice (*Peromyscus maniculatus gracilis*) known to occur in the area. Eight strings of cotton twine about a meter in length were suspended from the ceiling to provide the flies with additional resting sites. This test was conducted in early August when natural *E. muscae* infections are uncommon in the Ithaca area. It is a period generally characterized by warm sunny days with little rainfall and warm to cool nights.

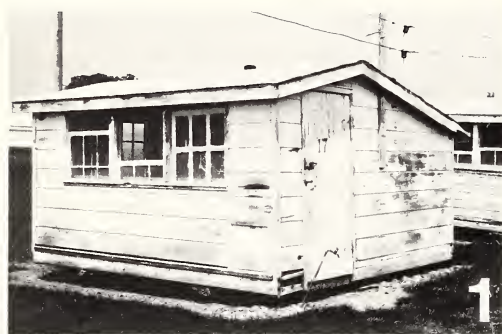
*Source of inoculum.* A group of about 250 healthy insectary-reared house flies was inoculated with our strain of *E. muscae* by a method described elsewhere (Kramer and Steinkraus, 1981). The flies were next held in the laboratory for about four days. They were then lightly anesthetized with carbon dioxide and the dorsa of their thoraxes marked with a dab of fast-drying nontoxic red paint. Since we had established that diseased flies generally die of the mycosis between post-exposure days 5 and 8 under laboratory conditions, we knew that these marked-infected flies would die within three days from the start of the field study.

*Procedures.* The marked-infected flies, plus a test group of about 400 young flies from a disease-free insectary colony, were released within the chicken house. This mixed population of flies was observed daily through the screened windows. A feeder consisting of a large tray containing a mixture of dried milk and sugar, plus a water fountain, was placed in the house to sustain the flies. At the end of the experiment, cadavers associated with various surfaces were counted and categorized as given in Table 1. Only specimens displaying typical post-mortem changes were scored as infected (see Fig. 3).

## RESULTS AND DISCUSSION

Observations made over the first three days of the experiment revealed that some flies from both the test group and the marked-infected group had died on the floor or had fallen to the floor after dying. By the eleventh day there were no signs of





Figs. 1-4. 1. Poultry building used in this study. 2. Cadavers of flies from the test group affixed to a substrate and displaying various stages of the post-mortem changes associated with the mycosis. 3. Two test-group cadavers from which showers of conidia are being produced. Note whitish layer of conidia covering under surface of the wing of the fly at the right. 4. Adult Canadian deer mouse eating cadavers of flies with *E. muscae* outgrowths. This mouse was trapped at the test site and fed cadavers in the laboratory without any ill effects.

movement or flight observable through the screened windows, and we entered the building. A careful search yielded no living flies. Intact cadavers were found on the ceiling, walls, strings and the feeder (Figs. 2, 3). A mixture of whole cadavers, piles of wings and legs, plus fecal pellets from mice, was found on the floor. About 80% of the flies within each group was recovered. In all likelihood the carcasses of the missing flies had been eaten by mice that had entered the building through the small holes in the floor (see Fig. 4).

The spatial distribution of cadavers within both groups is given in Table 1. In each case about 50% of the flies had died on or fallen to the floor, while another 35 to 40% had died on the strings or the feeder. Only 10 to 15% were found on the walls and ceiling. Clearly all surfaces frequented by healthy flies may also serve as final roosting sites for individuals that succumb to the mycosis. This might promote a rather good distribution of infective conidia within the general environment.

While 100% of the cadavers recovered from the marked-infected group displayed the characteristic post-mortem changes associated with the mycosis, only 92% of the cadavers from the test group did so. The collection of dead flies lacking typical post-mortem changes was not studied in detail. A majority of them, however, probably had died within the first few days of the experiment and thereby escaped the mycosis. Hence, the actual incidence of fatal *E. muscae* infections in flies that had lived for seven to nine days within the test group probably approached or reached 100%.

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## NOTES AND COMMENTS

### ***POLYBIA (MYRAPETRA) PAULISTA* (HYMENOPTERA: VESPIDAE), AN AERIAL PREDATOR OF SWARMING ANTS (HYMENOPTERA: FORMICIDAE) IN BRAZIL**

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During reproduction in the majority of ant species, alate males and females leave the nest to mate and disperse. Generally, male ants exit before females, and in at least some species, form leks (Brian, 1983). It is also during the nuptial flight, or swarming, that extreme mortality of reproductives occurs, chiefly through predation and execution by conspecifics (Brian, 1965). Some predators of reproductive ants during the period of nuptial flight include social wasps. Van der Vecht (1957) and Chapman (1963) have described how social wasps actively capture ants in swarms. In both cases, the aerially captured ants were dismembered, and wasps apparently returned to their nest with small balls of ant meat, or with ant hemolymph carried in their crops.

In South America, polybiine wasps are locally quite abundant, and, in some cases, construct enormous nests (Richards and Richards, 1951). Many of the polybiine genera, like their vespoid relatives, are general predators. In a recent study, Gobbi et al. (1984) found that the prey of *Polybia occidentalis occidentalis* (Olivier) was largely alate ants during the spring (September and October). Like other species of the genus, *P. occidentalis* stores intact prey in the lower levels of the enclosed aerial nest. If prey are particularly abundant, colonies tend to overstock. In these cases, more prey are stored than can be fed to the larvae in a reasonable time period, and fungal contamination of the stored prey often occurs (Gobbi, 1984).

This note discusses the predatory behavior of *Polybia paulista* (Ihering) on swarms of *Conomyrma*, probably *brunnea* (Forel) in central Brazil.

Swarms of *Conomyrma* formed between 11 A.M. and 1 P.M. (ST) over a grassy field in Rio Claro, São Paulo, Brazil, on 7 and 8 September 1985. This diurnal time window is within the expected flight period of *Conomyrma* (MacKay and MacKay, 1984). The first rainfall in over one month fell on 6 September. Swarms formed over taller herbaceous vegetation or fenceposts at heights of 1 to 2 m. Swarm density was approximately 700/ha, with swarms occurring about every 5 m. Swarms were generally compact, 30 to 40 cm in diameter, and tended to move vertically and horizontally continuously.

An aerial net, 38 cm in diameter, was used to sample swarms. One sweep was made through the center of each swarm sampled. Each sweep sample was placed in alcohol and sorted in the laboratory. The number of male and female *Conomyrma* and *P. paulista* workers per sample was recorded.

The number of *P. paulista* workers per swarm was found to be highly correlated with lek size ( $r = 0.754$ ,  $P < 0.001$ ), suggesting that *P. paulista* was responding numerically to swarm size. Individual captures of 22 *P. paulista* workers leaving swarms

indicated that all had captured only males. Because of this, it is probable that *P. paulista* has a minimal effect on the population dynamics of *Conomyrma*. However, swarms of ants may provide an abundant resource to spur colony growth of *P. paulista* in the spring, allowing it to attain colony population levels capable of controlling populations of its summer prey, Hemiptera and Homoptera (Gobbi et al., 1984). — H. G. Fowler, Instituto de Biociências, Universidade Estadual Paulista (UNESP), 13,500 Rio Claro, São Paulo, Brazil.

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## BOOK REVIEW

**Aphid Ecology.**—A. F. G. Dixon. 1985. Blackie & Son Ltd., Glasgow. 157 pp. Hardbound: \$39.95/Chapman & Hall, £17.95/Blackie.

Aphids are a unique group of phloem-feeding insects that display such unusual attributes as cyclical parthenogenesis, extensive polymorphism, and telescoping of generations. Although this group contains only about 4,000 species, aphids have been the object of a substantial amount of research by temperate zone entomologists. One reason behind this impressive research effort is the impact of aphids on economically important plants. The frequent abundance of aphid populations has also led to their use by many as experimental animals or models for population studies. Thus, the literature on aphid biology and ecology can be formidable. In this book, Dixon summarizes the knowledge on many of the diverse aspects of aphid biology and ecology.

The term ecology in this book is "used in a broad sense to include aspects of the basic biology of the group necessary for an understanding of the population and community levels of organization." Topics presented include much more than just the ecology of aphids, as many would define this term. The eight chapters cover host selection, aphid size, polymorphism, cyclical parthenogenesis, life-history patterns, dispersal, population dynamics, and community structure and species diversity. I found that the integration of material as presented was refreshing. Quantitative relationships describing many aspects of aphids are intermingled with evolutionary questions. For example, genetic diversity within aphid populations and the advantages of sexuality are discussed within the chapter on parthenogenesis. Over 100 illustrations are provided to describe the many quantitative relationships presented in the text. At the end of each chapter, a helpful summary section ties together the information just presented. An introduction and epilogue set a framework for the body of the text and a short appendix of scientific and common names of the aphids discussed in the text is included.

Dixon presents a synthesis of valuable information drawing upon recent research as well as older studies for examples. A summary work of this sort is easy to criticize because some information must be excluded to present such a concise account. In doing so, Dixon presents many of his own ideas and theories and emphasizes the work done by himself and his students. Based on the number of studies which have been done on aphid population dynamics, as well as the natural enemies associated with aphids, these brief sections might well have been expanded—especially in a book titled *Aphid Ecology*.

The summary nature of this book and its abbreviated length would make it interesting reading for advanced students, teachers, and researchers in entomology, as well as in many other subdivisions of the biological sciences. Unfortunately, the price of \$39.95 may hinder many people other than aphidologists from purchasing this book. For people working on aphids, this book by one of the most preeminent researchers in this field is a must.—Ann E. Hajek, Department of Entomology, Cornell University, Ithaca, New York 14853.

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The *Journal of the New York Entomological Society* is devoted to the advancement and dissemination of knowledge of insects and related taxa. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie. The Journal will consider for publication manuscripts of any length dealing with original research in entomology. Longer papers will be printed as articles, shorter ones as "scientific notes." Book reviews will be solicited by the Book Review Editor.

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**TAXONOMIC NAMES PROPOSED IN THE INSECT ORDER  
HETEROPTERA BY JOSÉ CANDIDO DE MELO CARVALHO FROM  
1943 TO JANUARY 1985, WITH TYPE DEPOSITORIES**

JOSÉ C. M. CARVALHO<sup>1</sup> AND RICHARD C. FROESCHNER

Museu Nacional de Historia Natural, Quinta da Boa Vista,  
Rio de Janeiro, Brazil, and

United States National Museum of Natural History,  
Washington, D.C. 20560 U.S.A.

*Abstract.*—A list of taxonomic names of Heteroptera proposed by J. C. M. Carvalho alone or in coauthorship from 1943 to January 1985 is presented. Included are 1 subfamily, 5 tribes, 254 genera, and 1,260 species and subspecies. For each name the original reference is cited, and for holotypes the permanent depository is given.

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J. C. M. Carvalho's first work proposing new taxa in the Heteroptera was published in 1943, in coauthorship with Harry H. Knight, under the title "Neotropical Miridae: Two New Species of *Auchus* Distant from Brazil (Hemiptera)" (*Rev. Brasil. Biol.*, 3(1):83-85). At that time he was pursuing graduate studies at the University of Science and Technology at Ames, Iowa (then named Iowa State College).

On 6 April 1946, as a Specialized Technician on the staff of the National Museum, Rio de Janeiro, his twenty-second work on Miridae, entitled "Mirídeos neotropicais, XXII. Três gêneros novos do Brasil (Hemiptera)," was published in the "Boletim do Museu Nacional, Zoologia" 59:1-6, 17 figs. From that date to the present time, the author has performed his researches at that Institution.

<sup>1</sup> Research Fellow of the National Council for Scientific and Technological Development (CNPq), Brasília.

In the period between 1951 and 1955, during visits to European and North American Museums, several works were published in coauthorship with colleagues from the British Museum of Natural History, the Museum of Zoology, University of Helsinki, the Riks Museum of Natural History, Stockholm, and the United States National Museum of Natural History, Washington, D.C.

The "Catalogue of Miridae of the World," published from 1957–1960, included all of Carvalho's works through the end of 1955. That catalogue contains bibliographical data but no mention of where types were deposited. Such data could be obtained only from the original descriptions.

The present list, comprising names proposed by Carvalho and co-authors during the period from 1943 to January 1985 includes 1 subfamily, 5 tribes, 254 genera, and 1,260 species and subspecies and is offered to facilitate research of other hemipterists. It provides indications of the original depositories of the holotypes and the present one if they were subsequently moved.

#### USE OF LIST

Names are listed alphabetically by family, genus, and species. The isometopids, often recognized as a family, are treated as part of the Miridae for purposes of this List.

Each name is followed by its author(s), the year of publication, and a literature citation [see list at end of paper for full spelling] for the original description. For species the following additional information is given: Holotype (designated by "H") and its sex (if discernable), data as given on the label, allotype (if designated, signified by "A"), and for paratypes (designated by "P") the number, the sex (if given in the original description), and an abbreviated name [see list at end of paper for full spelling] of the collection in which the holotype is to be found. Where subgeneric names were used with the original proposal of a species they are indicated in this list by their initial letter in parentheses placed between the genus and trivial name without influencing the alphabetical position of the trivial name. See the following example:

*Cyrtopeltus (T.) infumatus* Carvalho, 1947

Bol. Mus. Nac. Zool. 77:16, fig. 9; H ♂, Carmo do Rio Claro, M. Gerais, 1945 (Carvalho col.); A 1♀, P 13♂♂, 14♀♀; MN (ex-JCMC).

Names proposed for preoccupied combinations have no type-data unless the junior homonym was proposed by Carvalho, then the type-date will be found under that name.

Carvalho named some "varieties" for convenience in dealing with marked color variants; they are not in all cases valid under the International Code. To reflect this status, varietal names are given without type-data or type-depository. Valid infra-specific names are given as trinomials with type-data and type-depository.

For full spelling of type-depositories and titles of literature cited see lists at end of this paper.

In the great majority of cases the allotype is deposited together with the holotype, but not necessarily so; paratypes are frequently found in more than one collection. The exact distribution of these specimens can be found in the original or later publications.

Holotypes of species described from Brazil are deposited in the collection of Het-

eroptera, National Museum, Rio de Janeiro. The types of the majority of these species were originally placed in the Carvalho collection ("author's collection"), and are now transferred to the National Museum Collection as indicated by the abbreviation MN (ex-JCMC). Holotypes of mirids originally placed in other national collections in Brazil but presently transferred to the National Museum are treated in a similar manner, e.g., MN (ex-IEA) [meaning: National Museum: ex-Instituto de Experimentação Agrícola, Universidade Federal Rural do Estado do Rio de Janeiro].

Primary types from countries other than Brazil and originally designated as deposited in the Carvalho collection have been transferred to various institutions and their new depository is indicated herein.

#### ACKNOWLEDGMENTS

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#### LIST OF NAMES PROPOSED

##### Family Anthocoridae Genus-Group Names

###### *Bilianella* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):388 (as "Isometopidae").

###### *Biliola* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):386 (as "Isometopidae").

##### Species-Group Names

###### *Bilianella minuta* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):389, fig. 2b (as "Isometopidae"); H ♂, S. Africa, R. E. Turnes, 1924 289, Port Saint John, Pondoland, May, 1924; A ♀, P 3 specimens; BMNH.

###### *Biliola castanea* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):388, fig. 2d (as "Isometopidae"); H ♂, S. India, Nandidrug Hill, 4,500 ft. Dr. T. N. Campbell, B.M. 1928 189 (Carded specimen); P 1 specimen; BMNH.

###### *Biliola microscopica* Carvalho, 1952

Rev. Brasil. Biol. 12(1):23, fig. 1 (as "Isometopidae"); H ♀, Mt. d'Ambre, XII.1948, Institut Scientifique de Madagascar, R. P. col.; MHNP.

###### *Piezostethus machadoi* Carvalho, 1952

Publ. Cult. Comp. Diam. Angola 15:19, fig. 1; H ♀, Angola, 1488.1 (Dundo, in vegetable detritus on forest floor; floresta "hiemilignosa"), IV.1949, A. de Barros Machado col.; P ♀; MHNP.



## Family Cydnidae

*Scaptocoris giselleae* Carvalho, 1952

Bol. Mus. Nac. Zool. 110:1, fig. 1; H ♂, Senambetiba, D. Federal, Brasil, 7.VII. 1951, Giselle Machline col.; A ♀, P 1 adult and several nymphs; MN.

## Family Gerridae

*Rheumatobates curracis* Drake and Carvalho, 1954

Proc. Biol. Soc. Wash. 67:225; H ♂, Eirunepe, Rio Jurua, Amazonas, Brasil, 1950, Jose C. M. Carvalho; A ♀, P 3; MN.

## Family Mesoveliidae

*Darwinivelia polhemi* Carvalho, 1984

Amaz. 8(4):519, figs. 1-13; H ♂, Marudá, Pará, Brasil, R. Arle; P 5♂♂, 5♀♀; MN.

## Family Miridae

## Suprageneric Names

Austromirini Carvalho, 1976

Rev. Brasil. Biol. 36(1):55.

Hyaliodini Carvalho & Drake, 1943

Rev. Brasil. Biol. 3(1):87.

Hyalopeplini Carvalho, 1951

Trans. IX Int. Congr. Ent. 1:133.

Palaucorinae Carvalho, 1956

Ins. Micronesia 7(1):47.

Saturniomirini Carvalho, 1952

Trans. IX Int. Congr. Ent. 1:134.

Surinamellini Carvalho & Rosas, 1962

Rev. Brasil. Biol. 36(1):430.

## Genus-Group Names

*Adfalconia* Carvalho & Rosas, 1962

Rev. Brasil. Biol. 22(4):427.

*Adfalconisca* Carvalho, 1983

Rev. Brasil. Biol. 43(2):149.

*Adhyalopeplus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):478.

*Adneella* Carvalho, 1960

Arq. Mus. Nac. R. J. 50:47.

*Adparafurius* Carvalho & Gomes, 1971

An. Acad. Brasil Ci. 43(2):461.

*Adphytocoris* Carvalho & Gomes, 1969

An. Acad. Brasil. Ci. 41(3):430.

- Adpiasus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):39 (1973).
- Adsaileria* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):31 (1973).
- Adtaedia* Carvalho & Gomes, 1971  
Rev. Brasil. Biol. 31(2):205.
- Adxenetus* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):116 (1973).
- Aitkenia* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:40.
- Allommatisca* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):105 (1973).
- Amapacylapus* Carvalho & Fontes, 1968  
Rev. Brasil. Biol. 28(3):279.
- Amapafurius* Carvalho, 1981  
Rev. Brasil. Biol. 41(1):17.
- Amapamiris* Carvalho, 1980  
Rev. Brasil. Biol. 40(2):307.
- Amazonocoris* Carvalho, 1952  
Rev. Brasil. Biol. 12(3):267.
- Ambercylapus* Carvalho & Popov, 1984  
An. Acad. Brasil. Ci. 56(2):203.
- Ambunticoris* Carvalho, 1981  
Arq. Mus. Nac. R. J. 46:52.
- Amulacoris* Carvalho & China, 1959  
Rev. Brasil. Biol. 19(1):69.
- Anomalocornis* Carvalho & Wygodzinsky, 1945  
Rev. Brasil. Biol. 5(1):32.
- Anosibeia* Carvalho, 1953  
Mem. Inst. Sci. Madagascar, Ser. E 3:47.
- Antennomiris* Carvalho & Schaffner, 1977  
Rev. Brasil. Biol. 37(2):363.
- Apachemiris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):65 (1973).
- Araucanocoris* Carvalho, 1983  
Rev. Brasil. Biol. 43(4):413.
- Araucanophylus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):154.
- Archeofulvius* Carvalho, 1966  
Rev. Brasil. Biol. 26(2):199.
- Aristotelesia* Carvalho, 1947  
Rev. Brasil. Biol. 7(2):255.
- Arlemiris* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):152.
- Aterpocoris* Carvalho & Becker, 1957  
An. Acad. Brasil. Ci. 29(2):285.

- Austrohyaloma* Carvalho & Gross, 1979  
Rec. S. Austr. Mus. 17(30):432.
- Aztecariella* Carvalho, 1951  
Entomologist 84:232.
- Aztecarina* Carvalho, 1975  
Rev. Brasil. Biol. 34(1):46.
- Bahiamiris* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):499.
- Bahianisca* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(2):237.
- Bergmiris* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):160.
- Bicurvicoris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):17 (1973).
- [*Bilianella*—see under Anthocoridae]
- [*Biliola*—see under Anthocoridae]
- Bilirania* Carvalho, 1956  
An. Acad. Brasil. Ci. 28(2):215.
- Bispinocoris* Carvalho, 1977  
Rev. Brasil. Biol. 37(3):623.
- Blesingia* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:46.
- Bolivicapsus* Carvalho & Fontes, 1967  
Rev. Brasil. Biol. 27(4):385.
- Boliviocoris* Carvalho & Fontes, 1967  
Rev. Brasil. Biol. 27(4):387.
- Borgmeierea* Carvalho, 1956  
Rev. Brasil. Biol. 16(2):235.
- Botocudomiris* Carvalho, 1979  
Rev. Brasil. Biol. 39(2):479.
- Brachyfulvius* Carvalho, 1955  
Proc. U.S. Nat. Mus. 103(3337):621.
- Brasiliocarnus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):377 (1984).
- Brasiliomiris* Carvalho, 1946  
Bol. Mus. Nac., Zool. 72:6.
- Bryocorella* Carvalho, 1956  
Ins. Micronesia 7(1):22.
- Bryocorellisca* Carvalho, 1981  
Arq. Mus. Nac. R. J. 46:57.
- Bugabacoris* Carvalho & China, 1959  
Rev. Brasil. Biol. 19(1):72.
- Bunsua* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1-2):105.
- Caiganga* Carvalho & Becker, 1957  
Rev. Brasil. Biol. 17(2):197.

- Callichilella* Carvalho, 1954  
An. Acad. Brasil. Ci. 26(3-4):427.
- Carassacoris* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):323 (1984).
- Carijoanus* Carvalho, 1954  
An. Acad. Brasil. Ci. 26(3-4):423.
- Carinimiris* Carvalho, 1981  
Arq. Mus. Nac. J. R. 46:59.
- Carmelinus* Carvalho & Gomes, 1972  
Rev. Brasil. Biol. 32(1):102.
- Carmelocoris* Carvalho & China, 1959  
Rev. Brasil. Biol. 19(1):70.
- Cearana* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):133 (1973).
- Ceratocapsisca* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 35(4):625 (1975).
- Ceratocapsella* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):75 (1973).
- Cheesmaniella* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):117.
- Chileaia* Carvalho, 1944  
Rev. Ent. R. J. 15(1-2):150.
- Chiloephyllus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):162.
- Chinamiris* Carvalho, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:168.
- Clivinemidea* Carvalho & Gomes, 1970  
Rev. Brasil. Biol. 30(4):595.
- Coleopteromiris* Carvalho, 1945  
Bol. Mus. Nac. Zool. 59:1.
- Collesicoris* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:53.
- Corcovadocola* Carvalho, 1948  
Rev. Brasil. Biol. 8(4):525.
- Coridromoides* Carvalho, 1956  
Ins. Micronesia 7(1):34.
- Crassicollus* Carvalho, 1947  
Bol. Mus. Nac., Zool. 83:4.
- Crassicornus* Carvalho, 1945  
Rev. Brasil. Biol. 5(2):303.
- Crassiembolius* Carvalho, 1981  
Arq. Mus. Nac. R. J. 46:59.
- Cuneocoris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):33 (1973).
- Cuneomiris* Carvalho, 1981  
Arq. Mus. Nac. R. J. 46:60.



- Cylapocerus* Carvalho & Fontes, 1968  
Rev. Brasil. Biol. 28(3):277.
- Cylapocoris* Carvalho, 1954  
Proc. Iowa Acad. Sci. 61:507.
- Cylapoides* Carvalho, 1952  
Rev. Brasil. Biol. 12(3):269.
- Cyrtotyloides* Carvalho & Maldonado, 1982  
Rev. Brasil. Biol. 42(3):559.
- [*Domingocoris*—lapsus, see *Domingomiris*]  
*Domingomiris* Carvalho, 1980  
Rev. Brasil. Biol. 40(3):431. Correct in genus and species headings, misspelled  
*Domingocoris* in captions for illustrations.
- Duckecylapus* Carvalho, 1982  
Acta Amazon. 12(4):811.
- Eglerocoris* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(3):335.
- Emboliocoris* Carvalho & China, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:682.
- Esalquinus* Carvalho, 1980  
Rev. Brasil. Biol. 40(3):433.
- Eurychiloides* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):462.
- Excentricoris* Carvalho, 1955  
Beitr. Ent. 5(3–4):334.
- Felisacoris* Carvalho, 1956  
Ins. Micronesia 7(1):24.
- Femurocoris* Carvalho, 1977  
Rev. Brasil. Biol. 37(3):625.
- Fennahiella* Carvalho, 1955  
Rev. Chil. Ent. 4:223, n.n. for *Haitiana* Carvalho, 1952, n. preoc. by *Haitiana*  
Dozier, 1936, Amer. Mus. Nov. 845:2.
- Fieberocapsus* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(1):33.
- Formicomiris* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 35(2):349.
- Frotaphylus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):170.
- Frontimiris* Carvalho, 1981  
Arq. Mus. Nac. R. J. 46:66.
- Galapagocoris* Carvalho, 1968  
Proc. Cal. Acad. Sci., Fourth Ser. 36(7):179.
- Galapagomiris* Carvalho, 1968  
Proc. Cal. Acad. Sci., Fourth Ser. 36(7):187.
- Ganocapsinus* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):48.
- Ganocapsoides* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):47 (1973).

- Garainamiris* Carvalho, 1981  
Rev. Brasil. Biol. 41(3):479.
- Gauchocoris* Carvalho, 1980  
Rev. Brasil. Biol. 40(2):300.
- Gaveanus* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):49.
- Gollneria* Carvalho, 1983  
Rev. Brasil. Biol. 43(4):383.
- Gonzalezinus* Carvalho, 1981  
Rev. Brasil. Biol. 41(1):11.
- Grossicoris* Carvalho, 1973  
Rev. Brasil. Biol. 33(4):1.
- Guanabarea* Carvalho, 1948  
Rev. Brasil. Biol. 8(4):532.
- Guaramiris* Carvalho, 1980  
Rev. Brasil. Biol. 40(2):311.
- Guarana* Carvalho & China, 1951  
Entomologist 84(1056):113.
- Guerreroecoris* Carvalho & China, 1959  
Rev. Brasil. Biol. 19(1):70.
- Guianella* Carvalho, 1948  
Bol. Mus. Nac., Zool. 72:4.
- Guisardinus* Carvalho, 1979  
Rec. S. Austr. Mus. 17(3):441.
- Hadronemella* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):51.
- Hadronemisca* Carvalho, 1973  
Rev. Brasil. Biol. 33(1):19.
- Haitiana* Carvalho, 1952  
An. Acad. Brasil. Ci. 24(2):179.
- Hallodapoides* Carvalho, 1951  
Ann. Nat. Mus. Wien 58:105.
- Hambletoniola* Carvalho, 1954  
Ent. News. 65(5):123.
- Harrisia* Carvalho, 1983  
Rev. Brasil. Biol. 43(2):148.
- Herdonisca* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):135 (1973).
- Horciasinus* Carvalho & Jurberg, 1974  
Rev. Brasil. Biol. 34(1):51.
- Horciasisca* Carvalho, 1976  
Rev. Brasil. Biol. 36(1):99.
- Horciasoides* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):430.
- Hyaliodomiris* Carvalho, 1946  
Bol. Mus. Nac., Zool. 59:5.

- Hyalopeplinus* Carvalho, 1979  
Rec. S. Austr. Mus. 17(30):451.
- Hyaloplictus* Carvalho, 1979  
Rec. S. Austr. Mus. 17(30):511.
- Hyalopsallus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):19 (1973).
- Icoracicoris* Carvalho, 1980  
Rev. Brasil. Biol. 40(2):313.
- Incacoris* Carvalho, 1961  
Rev. Brasil. Biol. 21(4):463.
- Incafulvius* Carvalho, 1976  
Rev. Brasil. Biol. 36(3):715.
- Incamiris* Carvalho & Ferreira, 1972  
Rev. Brasil. Biol. 32(2):177.
- Irazucoris* Carvalho, 1972  
Rev. Brasil. Biol. 32(1):45.
- Irianocoris* Carvalho, 1971  
Rev. Brasil. Biol. 31(1):15.
- Isoldalinus* Carvalho & Felipe, 1983  
Rev. Brasil. Biol. 43(3):278.
- Isometocoris* Carvalho & Sailer, 1954  
Ent. News 65(4):86.
- Itacoris* Carvalho, 1947  
An. Acad. Brasil. Ci. 19(1):103.
- Jessopocoris* Carvalho, 1981  
Rev. Brasil. Biol. 41(3):480.
- Joceliana* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):361 (1984).
- Jordandinus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):69 (1973).
- Jordanofulvius* Carvalho, 1954  
Beitr. Ent. 4(2):188.
- Juarezicoris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):23 (1973).
- Kamaiurana* Carvalho, 1952  
Rev. Brasil. Biol. 12(3):265.
- Knightiella* Carvalho & Drake, 1943  
Rev. Brasil. Biol. 3(1):87.
- Knightocoris* Carvalho & China, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:686.
- Knightonia* Carvalho, 1944  
Rev. Ent. R. J. 15(1-2):239.
- Koluenia* Carvalho, 1952  
Bol. Mus. Nac., Zool. 112:1.
- Krainacoris* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 35(4):629 (1975).

- Kunungua* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1-2):107.
- Kuscheliana* Carvalho, 1952  
Rev. Chil. Ent. 2:21.
- Leptomiris* Carvalho & Becker, 1957  
Rev. Brasil. Biol. 17(2):199.
- Lestoniella* Carvalho & Becker, 1957  
An. Acad. Brasil. Ci. 29(2):288.
- Limonia* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):267 (1984).
- Linacoris* Carvalho, 1983  
Rev. Brasil. Biol. 43(4):405.
- Lindbergiola* Carvalho, 1951  
An. Acad. Brasil. Ci. 23(4):385.
- Lundbladiolla* Carvalho, 1955  
Bol. Mus. Goeldi 11(2):20.
- Lundiella* Carvalho, 1951  
Ent. Medd. 26:132.
- Madagascariella* Carvalho, 1953  
Mem. Inst. Sci. Madagascar, Ser. E 3:44.
- Malgacheocoris* Carvalho, 1952  
Mem. Inst. Sci. Madagascar, Ser. E 1(1):95.
- Matogrossia* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):383 (1984).
- Maxacalinus* Carvalho, 1976  
Rev. Brasil. Biol. 36(4):759.
- Maxacalisca* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 36(4):627 (1975).
- Megamirioides* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):313 (1984).
- Mexicomiris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):42 (1973).
- Microoculis* Carvalho, 1982  
Rev. Brasil. Biol. 42(2):313.
- Millerimiris* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1-2):103.
- Minasmiris* Carvalho, 1980  
Lundiana 1:129.
- Miomonalonion* Sailer & Carvalho, 1957  
U.S. Geol. Surv. Prof. Paper 294-G:257.
- Mixtecamiris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):26 (1973).
- Muirmiris* Carvalho, 1983  
Rev. Brasil. Biol. 43(2):147.
- Myombea* China & Carvalho, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:1120.



- Nabirecoris* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:78.
- Nanniresthenia* Carvalho, 1961  
Rev. Brasil. Biol. 21(4):461.
- Nannomiris* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):497.
- Neocaulotops* Carvalho & Gomes, 1971  
Rev. Brasil. Biol. 31(1):65.
- Neotropicormiris* Carvalho & Fontes, 1969  
Rev. Brasil. Biol. 29(3):332.
- Nigrimiris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):20 (1973).
- Notholopisca* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):369.
- Notholopoides* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):369.
- Nototremates* Carvalho & China, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:680.
- Oaxacaenus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):71 (1973).
- Odontocerocoris* Carvalho & China, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:678.
- Opistheurista* Carvalho, 1959  
Arq. Mus. Nac. R. J. 48:347.
- Pachymerocerista* Carvalho & Gomes, 1971  
Rev. Brasil. Biol. 31(1):99.
- Pachymeroceroides* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):468.
- Pachypoda* Carvalho & China, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:688.
- Palaucoris* Carvalho, 1956  
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- Panamacoris* Carvalho & Gomes, 1971  
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- Parabryocoropsis* China & Carvalho, 1951  
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- Paracylapus* Carvalho, 1952  
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- Paradacerla* Carvalho & Usinger, 1957  
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- Parafulvius* Carvalho, 1954  
Proc. Iowa Acad. Sci. 61:504.
- Parafurius* Carvalho & China, 1951  
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- Penacoris* Carvalho & Rosas, 1966  
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- Peritropisca* Carvalho & Lorenzato, 1978  
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- Peritropoides* Carvalho, 1955  
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- Peruanocoris* Carvalho, 1953  
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- Phytocorisca* Carvalho & Fontes, 1972  
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- Platytyliscus* Carvalho, 1976  
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- Platytyloides* Carvalho & Fontes, 1971  
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- Plaumannocoris* Carvalho, 1947  
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- Porophoroptera* Carvalho & Gross, 1982  
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- Prepopsella* Carvalho, 1975  
An. Acad. Brasil. Ci. 46(2):303 (1974).
- Prepopsoides* Carvalho & Schaffner, 1975  
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- Proneella* Carvalho, 1960  
Arq. Mus. Nac. R. J. 50:48.
- Protaedia* Carvalho, 1975  
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- Proxenetes* Carvalho & Ferreira, 1974  
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- Pseudodoniella* China & Carvalho, 1951  
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- Pygophorisca* Carvalho & Wallerstein, 1978  
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- Queretarius* Carvalho & Schaffner, 1974  
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- Quichuamiris* Carvalho, 1975  
An. Acad. Brasil. Ci. 46(2):325 (1974).
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- Rotundomiris* Carvalho, 1981  
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- Schaffnerisca* Carvalho, 1975  
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- Schoutedenomiris* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1-2):100.
- Sericophanoides* Carvalho & Rosas, 1965  
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- Setocoris* China & Carvalho, 1951  
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- Singhalesia* China & Carvalho, 1952  
Ann. Mag. Nat. Hist., Ser. 12 5:165.
- Sixeonotopsis* Carvalho & Schaffner, 1974  
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- Solanocoris* Carvalho, 1945  
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- Stenopterocorisca* Carvalho, 1981  
Arq. Mus. Nac. R. J. 46:83.
- Surinamella* Carvalho & Rosas, 1962  
Rev. Brasil. Biol. 22(4):430.
- Tamoicoris* Carvalho, 1984  
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- Tapuruyunus* Carvalho, 1946  
Bol. Mus. Nac., Zool. 59:3.
- Taricoris* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:84.
- Teratofulvioides* Carvalho & Lorenzato, 1978  
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- Termatophylella* Carvalho, 1955  
Proc. U.S. Nat. Mus. 104(3348):643.
- Termatophyloides* Carvalho, 1955  
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- Tibiocoris* Carvalho & Gomes, 1970  
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- Totolapanus* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 35(2):351.
- Trigonotyliscus* Carvalho, 1974  
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- Tucuruiella* Carvalho, 1982  
Acta Amazon. 12(1):181.
- Tupimiris* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):35 (1973).
- Tupiniquinus* Carvalho, 1984  
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- Tupiocoris* China & Carvalho, 1952  
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- Tuxenella* Carvalho, 1952  
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- Tylonisca* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):82.
- Ueleana* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1-2):102.
- Umboiella* Carvalho, 1981  
Rev. Brasil. Biol. 41(3):461.
- Urubumiris* Carvalho, 1976  
Rev. Brasil. Biol. 35(4):683 (1975).
- Urucuiana* Carvalho & Rosas, 1965  
Rev. Brasil. Biol. 25(2):207.
- Usingerella* China & Carvalho, 1952  
Ann. Mag. Nat. Hist., Ser. 12 5:165.
- Vanniusoides* Carvalho & Lorenzato, 1978  
Rev. Brasil. Biol. 38(1):127.
- Veramiris* Carvalho, 1974  
Rev. Brasil. Biol. 34(4):464.
- Waterhouseana* Carvalho, 1973  
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- Woodwardiola* Carvalho, 1973  
Rev. Brasil. Biol. 33(4):5.
- Xoklengana* Carvalho & Rosas, 1965  
An. Acad. Brasil. Ci. 37(1):84.
- Yebonia* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1-2):110.
- Zanchismella* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 35(4):631 (1975).
- Zanchismisca* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 35(4):634 (1975).
- Zapotecoris* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 34(3):298.
- Zikaniola* Carvalho, 1946  
Bol. Mus. Nac., Zool., 61:4.

#### Species-Group Names

- Acegima brasiliiana* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):111, figs. 7-11 (1973); H ♂, Jacareacanga, Pará, Brasil, XII.1968, Alvarenga col; P 1♂; MN (ex-JCMC).
- Acegima guiana* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):113, fig. 12 (1973); H ♀, Paramaribo, Suriname, 15.X.1961; NMNH (ex-JCMC).



*Acrorrhinium brincki* Carvalho & Becker, 1960

S. Afr. Anim. Life 7:453, figs. 4, 26a-b; H ♀, Natal, The Hostel, Royal Park, 3.IV.1951, SSAE (No. 259); P 2♀♀; LUZI.

*Acrorrhinium pauliani* Carvalho, 1953

Mem. Inst. Sci. Madagascar, Ser. E 3:45, figs. 3K-L, 4D; H ♂, Route d'Ambatofinandrahana, sur Lin, I.1951, R.P. (genitalia mounted with the type); MHNP.

*Adelphocoris chilensis* Carvalho & Maldonado, 1973

Rev. Brasil. Biol. 33(1):41, figs. 9-13; H ♂, Chile, Rio Los Molles, Coquimbo, Nov.8.1961, L. F. Peña; A ♀, P 6♂♂, 3♀♀; NMNH (ex-JCMC).

*Adelphocoris lindbergi* Carvalho, 1955

Rev. Chil. Ent. 4:225, n.n. for *Adelphocoris insularis* Lindberg, 1933, n. preocc. by *Adelphocoris insularis* Poppius, 1915, Ann. Mus. Nat. Hung. 13:36.

*Adelphocoris quadripunctatus annulatus* Carvalho, 1959

Arq. Mus. Nac. R. J. 48:18, n.n. for *Adelphocoris quadripunctatus annulicornis* (Sahlberg, 1948) (as *Capsus annulicornis*), Mon. Geoc. Fenn., 100 n. preocc. by *Capsus annulicornis* Herrich-Schaeffer, 1835, Nomen. Ent., p. 51.

*Adfalconia cunealis* Carvalho & Rosas, 1962

Rev. Brasil. Biol. 22(4):428, figs. 1-5; H ♂, M. Gerais, Brasil, Viçosa, 8-43, Carvalho col.; A ♀, P 205; MN (ex-JCMC).

*Adfalconisca javanica* Carvalho, 1983

Rev. Brasil. Biol. 43(2):149, figs. 3-6; H ♂, Java, Pakalongao, F. Muir; P 3♂♂, 10♀♀; BMNH.

*Admetus brachycerus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(4):493, fig. 1; H ♀, Real de Arriba, Temescaltepec, Mex., VI.II.33; H. E. Hinton, R. L. Usinger Col; P 3♀♀; NMNH (ex-JCMC).

*Admetus mexicanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):324, figs. 35-38 (1984); H ♂, Guadalajara, Mexico, Crawford; NMNH.

*Admetus sulinus* Carvalho & Gomes, 1969

Rev. Brasil. Biol. 29(2):225, figs. 1-4; H ♂, Catamayo, III. 65, L. F. Peña col.; P 3♂♂; NMNH (ex-JCMC).

*Adneella carioca* Carvalho, 1985

Rev. Brasil. Biol. 44(3):290, fig. 94 (1984); H ♂, Brasil, Rio de Janeiro (ex-D.F.), Corcovado, 26.X.59, Alvarenga & Seabra col; MN.

*Adneella columbiensis* Carvalho, 1984

Rev. Brasil. Biol. 44(1):99, figs. 1-4; H ♂, Colombia, Putumayo, X.70, Borys Malkin col.; P ♂; NMNH (ex-JCMC).

*Adparafurius columbiensis* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):461, figs. 1-4; H ♂, Bogota, Colombia, II-1970, JCMC col.; A 1♀, P 2♀♀; NMNH (ex-JCMC).

*Adphytocoris longilineus* Carvalho & Gomes, 1969

An. Acad. Brasil. Ci. 41(3):432, figs. 43-47; H ♂, Troya, 2900 m. Ecuador, L. F. Peña col., III.65; P 1♂; NMNH (ex-JCMC).

*Adpiasmus mayanus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):41, figs. 2-5 (1973); H ♂, El Zapotal, 2 mi. S. Tux. Gutierrez, Chias., Mex., VIII.1.57, J. A. Chemsak, B. J. Rannells, collectors; A ♀, P 1♂, 1♀; CAS.

*Adpiasus punctatus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):40, fig. 1 (1973); H ♀, 8 mi. N. Catemaco, V. C. Mex., VI.9.65, Burke, Meyer, Schaffner; P ♀; NMNH.

*Adsaileria virescens* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):32, figs. 1–4 (1973); H ♂, Nova Teutonia, Santa Catarina, Brasil, 27 11' N [lapsus for S], 52 23' W, October, 1970, Fritz Plau-mann; P 19♂♂; MN (ex-JCMC).

*Adtaedia carioca* Carvalho, 1980

Rev. Brasil. Biol. 40(2):297, figs. 1–4; H ♂, Corcovado, Rio de Janeiro Brasil, J. C. M. Carvalho col., XI.1978; NM (ex-JCMC).

*Adtaedia corcovadensis* Carvalho, 1975

Rev. Brasil. Biol. 35(5):503, figs. 8–11; H ♂, Corcovado, Guanabara (Rio de Janeiro), Brasil, X.1962, Alvarenga & Seabra col; A ♀, P 1♀; MN (ex-JCMC).

*Adtaedia itatiaiensis* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):206, fig. 1; H ♀, Itatiaia, 700 m, 13-XI-1943, E. do Rio, Brasil, Vassoura Bl. J. F. Zikan; MN (ex-JCMC).

*Adtaedia tijucana* Carvalho, 1980

Rev. Brasil. Biol. 40(2):298, fig. 5; H ♀, Corcovado, Rio de Janeiro, Brasil, J. C. M. C. col., XI.1978; NM (ex-JCMC).

*Adxenetus minensis* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):118, figs. 8–12 (1973); H ♂, Varginha, Minas Gerais, IX.1961, M. Alvarenga leg; A ♀, P 2♀♀; MN (ex-JCMC).

*Adxenetus nordestinus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):119, figs. 13–17 (1973); H ♂, Juazeirinho, Soledade, Paraiba, Brasil, 20.III.1956, A.G.A. Silva; MN (ex-JCMC).

*Aitkenia cantrelli* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:44, figs. 70–71, 118C; H ♂, North Queensland, Split Rock, 14 km S Laura, 23–26.VI.1975, G. B. Monteith; P 1♂; QM.

*Aitkenia grandis* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:45, figs. 73–75, 120; H ♂, Victoria, 6 km S Warburton, 27.II.1976, A. Neboiss; P 1♂; NMV.

*Aitkenia latevagans* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:41, figs. 59–62, 118A; H ♂, Australian Capital Territory, Cotter River, 7.XII.1962, D. K. McAlpine; ANIC.

*Aitkenia monteithi* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:42, figs. 63–65, 119; H ♂, North Queensland, Pat Creek, 11 km N Archer Crossing, via Coen, 28–29.VI.1975, G. B. Monteith; P 1♂; QM.

*Aitkenia uptonia* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:43, figs. 66–69, 118B; H ♂, N. S. Wales, 8 km Northwest Coffs Harbour, 240 m, 1.XI.1965, M. S. Upton; P 4♂♂; ANIC.

*Alcecoris globosus* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):390, fig. 1 (as "*Alcerocoris*"); H ♀, S. India, Nandidrug Hill, 4500 ft Dr. T. V. Campbell coll. B.M. 1928 189; BMNH.

[*Alcerocoris globosus*—see *Alcecoris globosus*]

*Alda bahianus* Carvalho, 1976

Rev. Brasil. Biol. 36(4):765, figs. 1–4; H ♂, Estrada Rio-Bahia, Km 965, Motel

- da Divisa, 960 m, Encruzilhada, Bahia, Brasil, IX.1972, Seabra & Roppa col.; A ♀, P 5♂♂, 7♀♀; MN (ex-JCMC).
- Alda bifasciata* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):86, fig. 1; H ♀, Costa Rica, Ebene von Limon bei Las Mercedes, F. Nevermann leg. 28.XI.1923; P ♀; NMNH (ex-JCMC).
- Alda bocaina* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):87, figs. 2–5; H ♂, S. Bocaina, 1650 m, S. J. Barreiros, XI.1968, Alvarenga & Seabra col.; A ♀, P 6♂♂, 7♀♀; MN (ex-JCMC).
- Alda ecuatoriana* Carvalho & Gomes, 1969  
An. Acad. Brasil. Ci. 41(3):427, figs. 25–29; H ♂, Santa Isabel, Ecuador, 2.200 m, III.65, L. F. Peña col.; A ♀, P ♀; NMNH (ex-JCMC).
- Alda fuscipennis confluenta* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):88, figs. 6–8; H ♂, Pq. N. Itatiaya, E. do Rio, VI.1960, A. Silva col.; A ♀, P 8♂♂, 5♀♀; MN (ex-JCMC).
- Alda fuscipennis itatiaiana* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):90, figs. 12–14; H ♂, P. N. Itatiaya, R. J., 22.VII.63, Mielke col.; A ♀, P 7♀♀; MN (ex-JCMC).
- Alda fuscipennis serrana* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):91, figs. 15–18; H ♂, S. Bocaina, 1650 m. S. J. Barreiros, S. P. Brasil, XI.1968, Alvarenga & Seabra; A ♀, P 7♂♂, 5♀♀; MN (ex-JCMC).
- Alda fuscipennis similima* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):92, figs. 19–21; H ♂, E. do Rio (RJ), Brasil, Petropolis, 958; A ♀, P 7♂♂, 8♀♀; MN (ex-JCMC).
- Alda fuscipennis sulina* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):93, figs. 22–24; H ♂, Brasilien, Nova Teutonia, 27°11' S. 52°23' L., Fritz Plaumann, VII.1945; A ♀, P 2♂♂, 11♀♀; MN (ex-JCMC).
- Alda juruena* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):94, figs. 25–27; H ♂, Br 29, Rio Juruena, M. Grosso, Brasil, XI.1960, M. Alvarenga leg; A ♀, P ♂; MN (ex-JCMC).
- Alda paulistana* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):94, figs. 28–31; H ♂, Viradouro, S. Paulo, Monte col., 25.I; MN (ex-JCMC).
- Alda pechinchana* Carvalho & Gomes, 1969  
An. Acad. Brasil. Ci. 41(3):429, figs. 30–35; H ♂, Quito, IX. 62, J.C.M.C.; A ♀, P 59♂♂♀♀; NMNH (ex-JCMC).
- Alda planaltina* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(1):95, figs. 32–35; H ♂, Goiás, Brasil, R. Verde, Carvalho col.; A ♀, P 3♂♂, 3♀♀; MN (ex-JCMC).
- Allommatisca squamosa* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):106, figs. 1–6 (1973); H ♂, Bodoquena, Mato Grosso, XI.1941, Comissão do Instituto Oswaldo Cruz; P 4♂♂; MN (ex-JCMC).
- Allommatus guaranianus* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):93, figs. 17–24, 65, 67 (1973); H ♂, Fiebrig, Paraguai, S. Bernardino; A ♀, P 2♂♂; NMNH (ex-JCMC).
- Allommatus sulinus* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):98, figs. 42–48 (1973); H ♂, Catamarca, El Rodeio, 1.59, 1500 mts. R. Golbach; A ♀; MLP (ex-JCMC).

*Allommatus tupianus* Carvalho & Fierreira, 1974

Rev. Brasil. Biol. 33(Supl.):101, figs. 57–62, 70, 72–73 (1973); H ♂, Paraná, Brasil, Staviarski, 1946, J. C. M. C. leg; P 1♂; MN (ex-JCMC).

*Amapacylapus amapariensis* Carvalho & Fontes, 1968

Rev. Brasil. Biol. 28(3):280, figs. 9–10; H ♀, Rio Amapari Territorio do Amapá, III.64, J.C.M.C. col; MN (ex-JCMC).

*Amapafurius aporema* Carvalho, 1981

Rev. Brasil. Biol. 41(1):18, figs. 19–23; H ♂, Rio Aporema, Amapá, Brasil, 8.IX.1964, JCMC col.; MN (ex-JCMC).

*Amapamiris myrmecoides* Carvalho, 1980

Rev. Brasil. Biol. 40(2):308, figs. 1–5; H ♀, Rio Calçoene, 2.8.1961, Brasil, Amapá (AP), J. E. B. Bechyne col; P 2♂♂, 2♀♀; MN (ex-JCMC).

*Amazonocoris longipilosus* Carvalho, 1952

Rev. Brasil. Biol. 12(3):268, figs. 2–5; H ♂, Lower Amazon, Monte Alegre, 17.IX.1933, J. G. Myers 1933.400; BMNH.

*Amercylapus nigrus* Carvalho & Popov, 1984

An. Acad. Brasil. Ci. 56(2):204, figs. 1–2; H ♀, Baltic amber, ? Poland (No. 2344/40); MZW.

*Ambracius harrisi* Carvalho, 1951

Arq. Mus. Nac. R. J. 42:156, figs. 1–5; H ♂, Nogales, Arizona, Aug.16.1937, H. M. Harris col. (genitalia slide mounted together with type); NMNH (ex-JCMC).

*Ambracius mexicanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):322, fig. 29 (1984); H ♀, Mexico City, Mexico, VII.19.33, H.E. Hinton & R.L. Usinger; P 1♀; NMNH.

*Ambracius vittatus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):322, fig. 30 (1984); H ♀, Nova Teutonia, Santa Catarina, Brasil, 27°11' S 52°23' W May 1970, Fritz Plaumann; NM.

*Ambunticoris nigroembolatus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:54, figs. 60–63; H ♂, New Guinea, Neth. above Ifar, 500.750m, VI.23.1959, J. L. Gressitt; P 1♀; BPBM.

*Ambunticoris ochraceus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:53, figs. 56–59; H ♂, New Guinea, N E, Finisterre Range, Saidor, Kiambavi, VI.11–VII.22–29, 1958, W. W. Brandt; BPBM.

*Annona brasiliensis* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):252, figs. 11–14; H ♂, Nova Teutonia, Santa Catarina, Brasil, 27°11' N [lapsus for S], 52°23' W, IX.1971, Fritz Plaumann; A ♀, P 7♂♂, 3♀♀; NM (ex-JCMC).

*Annona fuscata* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):259, figs. 31–35; H ♂, Brasilien, Nova Teutonia, 27°11' B, 52°23' L, 193-, Fritz Plaumann; A ♀, P 50♂♂, 43♀♀; NM (ex-JCMC).

*Annona lepida* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):254, figs. 18–21; H ♂, Mexico, Veracruz, 8 mi. ne. Catemaco, 3.VII.1971, Clark, Murray, Hart, Schaffner; A ♀; NMNH.

*Annona maiscula* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):145, figs. 1–3; H ♀, Peru, Vilcanota; A ♂; NMNH (ex-JCMC).



*Annona mimica* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):250, figs. 7-10; H ♂, Mexico, Oaxaca, 11 miles north Candelaria Loxicha, 19.VII.1974, Clark, Murray, Ashe, Schaffner; P 4♂♂; NMNH.

*Annona murrayi* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):256, figs. 22-25; H ♂, Costa Rica, San Jose, 8.3 mi. N San Isidro del General, 30.VI.1972, R. R. and M. E. Murray; A ♀, P 3♂♂, 6♀♀; NMNH.

*Annona recurvata* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):257, figs. 26-30; H ♂, Colombia, Cundinamarca, Finca Bella Vista, nr. Sasaima, 7.VI.1965, P. R. and D. L. Craig; A ♀, P 3♀♀, 2♂♂; CAS.

*Annona variabilis* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):261, figs. 36-39; H ♂, Mexico, Veracruz, 11 mi. S. Mi-santla, 21.III.1975, Clark & Schaffner; A ♀, P 103♂♂, 78♀♀; NMNH.

*Anomalocornis ariasi* Carvalho, 1982

Acta Amazon. 12(3):658, figs. 2-3; H ♂, Brasil, Manaus, P. das Laranjeiras, 4.IX.81, Jorge Arias; INPA.

*Anomalocornis geijskesi* Carvalho & Wygodzinsky, 1945

Rev. Brasil. Biol. 5(1):34, figs. 1-7; H ♂, Kabelstation, Suriname, Geijskes leg., 27.X.1938; NMNH (ex-JCMC).

*Anomalocornis rondoniensis* Carvalho, 1984

Bol. Mus. Goeldi, Zool. 1(2):148, figs. 1-4; H ♂, Brasil, Rondônia, Ji-Paraná, XI. 1938, Roppa col.; P 1♂, 2♀♀; MN.

*Anomalocornis tucuruensis* Carvalho, 1984

Bol. Mus. Goeldi, Zool., 1(2):150, figs. 5-8; H ♂, Tucuruí, Pará, Brasil, 1.79, M. Alvarenga col.; P 1♂, 1♀; MN.

*Anosibeia orthotyloides* Carvalho, 1953

Mem. Inst. Sci. Madagascar, Ser. E 3:49, figs. 2, 3E-G; H ♂, foret au Nord d'Anosibe, I.51, R. P.; A ♀, P ♂; MHNP.

*Antennomiris brasiliensis* Carvalho & Schaffner, 1977

Rev. Brasil. Biol. 37(2):364, figs. 1-5; H ♂, Brazil, Nova Teutônia, Santa Catarina, 27°11' N [lapsus for S], 52°23' W, XI.1974, Fritz Plaumann; A ♀, P 1♂; MN (ex-JCMC).

*Antias argentina* Carvalho, 1982

Rev. Brasil. Biol. 42(2):326, fig. 1; H ♀, El Palmar, E. Rios, Republica Argentina, XI.1975, Diego Carpentero; MLP (ex-JCMC).

*Antias bahiensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):379, figs. 1, 3, 7 (1984); H ♀, Estr. Rio Bahia, km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil; P 2♂♂; MN.

*Antias boliviana* Carvalho, 1982

Rev. Brasil. Biol. 42(2):327, fig. 2; H ♀, Provincia Yungas, VII.964, 2500m, B. Malkin, Bolivia; NMNH (ex-JCMC).

*Antias brasiliensis* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):146, fig. 4; H ♂, S. Bocaina, 1650 m, S. J. Barrero, S P, Brasil, XI.1968, Alvarenga & Seabra cols; MN (ex-JCMC).

*Antias catarinensis* Carvalho, 1982

Rev. Brasil. Biol. 42(2):327, figs. 3-7; H ♂, Brasil. Nova Teutonia, Santa Catarina,

27°11' N [lapsus for S], 52°25' W, March 1972, Fritz Plaumann, P 2♂, 1♀; MN (ex-JCMC).

*Antias chilensis* Carvalho, 1946

Livro hom. d'Almeida 10:130, figs. 3, 11–13; H ♂, Chile; A ♀, P 3♀♀, 3♂♂; MCHN.

*Antias dominicana* Carvalho, 1982

Rev. Brasil. Biol. 42(2):329, figs. 8–11; H ♂, 3 mi W Haina, San Cristobal Prov., Republica Dominicana, Aug. 18, 1967, J. C. Schaffner; NMNH (ex-JCMC).

*Antias gaucha* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):147, figs. 5–8; H ♂, Brasilien, Nova Teutonia 27°11' S, 52°23' L, XI.1944, Fritz Plaumann; A ♀, P 15♂♂, 17 ♀♀; NM (ex-JCMC).

*Antias guaraniana* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):148, figs. 9–11; H ♂, Paraguay, Caaguazu District, Estancia Primera, 28.XI.1931, R. P. Hussey, em yerba mate; P ♂; NMNH (ex-JCMC).

*Antias maldonadoi* Carvalho, 1982

Rev. Brasil. Biol. 42(2):330, figs. 12–16; H ♂, Republica Dominicana, Constanza, July 1969, J. Maldonado Capriles; NMNH.

*Antias mexicana* Carvalho, 1982

Rev. Brasil. Biol. 42(2):331, figs. 17–20; H ♂, Real de Arriba, Temescaltepec, Mexico, V.23.1933, H. E. Hinton, R. L. Usinger; P 3♀♀; NMNH (ex-JCMC).

*Antias minuscula* Carvalho, 1955

Rev. Brasil. Biol. 15(1):111, figs. 1, 5; H ♂, Arecibo, P. R., 26.III.34, S. Juan No. 5269 (on grapefruit); A ♀, P 17♂♂, 10♀♀; NMNH.

*Antias paraensis* Carvalho, 1982

Rev. Brasil. Biol. 42(2):332, fig. 21; H ♀, Belém. Pará, Brasil, A. Mendes, V.78; P 1♀; MN (ex-JCMC).

*Antias semispherica* Carvalho, 1982

Rev. Brasil. Biol. 42(2):333, fig. 22; H ♀, Nova Teutonia, Santa Catarina, Brasil, 27°11' N, 52°23' W, September, 1970, Fritz Plaumann; MN (ex-JCMC).

*Antias vittata* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):149, figs. 12–15; H ♂, Trinidad, em algodao, B.W.I.; A ♀, P 1♂, 2♀♀; NMNH (ex-JCMC).

*Apachemiris areolatus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):66, figs. 1–4 (1973); H ♂, Texas, El Paso Co., Hueco Tanks, 15 May 1971, at light, Murray & Gaumer; A ♀, P 3♂♂, 1♀; NMNH.

*Apachemiris minor* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):67, figs. 5–8 (1973); H ♂, 8 miles West of El Limon, Tamaulipas, Mexico, July 20, 1970, taken at light, Murray, Phelps, Hart, Schaffner; NMNH.

*Araspus bifasciatus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):60, fig. 1; H ♀, New Guinea, NE, Eliptamin Valley, 1200–1350 m, Aug. 1–15.1959, W. W. Brandt; BPBM.

*Araspus frontipallidus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):61, figs. 2–5; H ♂, New Guinea, NE, Okapa, Purosa, 1700–2000 m, 18.I.1966, J. L. Sedlacek; P 2♂♂, 4♀♀; BPBM.

*Araspus gressitti* Carvalho, 1984

Rev. Brasil. Biol. 44(1):62, figs. 6–9; H ♂, New Britain, Warongoi Val. Gazelle Pen., 100 m, V.25.1956, J. L. Gressitt; P 1♂, 2♀♀; BPBM.

*Araspus maai* Carvalho, 1984

Rev. Brasil. Biol. 44(1):62, figs. 10–13; H ♂, New Guinea, Neth, Vogelkop, Bomberai, 700–900 m, I.3.1959, T. C. Maa; P 1♀; BPBM.

*Araspus nigrus* Carvalho, 1948

Rev. Brasil. Biol. 44(1):63, fig. 14; H ♂, New Guinea, Papua, Kokoda, Piloki, 400 m, III.23.1956, J. L. Gressitt; P 2♂♂, 1♀; BPBM.

*Araspus notomaculatus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):64, fig. 15; H ♂, West New Guinea, Vogelkop, Kebar Va., W. Manokwari, 550 m. 4–31.I.1962, W. L. Quate; P 6♂♂, 2♀♀; BPBM.

*Araspus trapezinotus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):68, figs. 22–25; H ♂, New Guinea, Neth., Waris s. of Hollandia, 400–500 m, VIII.16–23, 1959, T. C. Maa; P 1♂, 5♀♀; BPBM.

*Araspus wauensis* Carvalho, 1984

Rev. Brasil. Biol. 44(1):69, figs. 26–29; H ♂, New Guinea, NE, Wau, 1400 m, 16.VI.1961, J. L. Gressitt; P 4♀♀, 3♂♂; BPBM.

*Araucanocoris araucanus* Carvalho, 1983

Rev. Brasil. Biol. 43(4):414, figs. 1–8; H ♂, Totor, Atacama, Chile, IX.52; 3♂♂, 3♀♀; NMNH (ex-JCMC).

*Araucanocoris fusconotatus* Carvalho, 1983

Rev. Brasil. Biol. 43(4):414, figs. 9–13; H ♂, A. Amarga, Atacama, Chile; P 13♂♂, 3♀♀; MLP (ex-JCMC).

*Araucanocoris nigricallosus* Carvalho, 1983

Rev. Brasil. Biol. 43(3):417, figs. 16–23; H ♂, Collon Cura, Neuquem, Argentina, Wygodzinsky col.; P 2♂♂, 5♀♀; MLP (ex-JCMC).

*Araucanocoris nigriscutis* Carvalho, 1983

Rev. Brasil. Biol. 43(4):417, figs. 29–33; H ♂, El Portillo, Atacama, Chile, IX.52; P 2♂♂, 11♀♀; NMNH (ex-JCMC).

*Araucanocoris orthotyloides* Carvalho, 1983

Rev. Brasil. Biol. 43(4):421, figs. 24–28; H ♀, Carrizal Bajo, Atacama, Chile, IX.52; P 14♂♂, 5♀♀; NMNH (ex-JCMC).

*Araucanocoris totorensis* Carvalho, 1983

Rev. Brasil. Biol. 43(4):421, figs. 34–40; H ♂, Los Choros, Coquimbo, Chile, IX.52; P 4♀♀; NMNH (ex-JCMC).

*Araucanocoris viridifemoratus* Carvalho, 1983

Rev. Brasil. Biol. 43(4):423, figs. 41–45; H ♂, Carrizal Bajo, Atacama, Chile, IX.52; P 12♂♂, 7♀♀; NMNH (ex-JCMC).

*Araucanocoris viridis* Carvalho, 1983

Rev. Brasil. Biol. 43(4):423, figs. 46–52; H ♂, Chacrita, Atacama, Chile, IX.52; P 3♂♂, 7♀♀; NMNH (ex-JCMC).

*Araucanophylus pacificus* Carvalho, 1984

Biol. Mus. Goeldi, Zool. 1(2):156, figs. 14–19; H ♂, Santiago, Chile, 1952, Kuschel col.; P 9♂♂, 9♀♀; CAS.

*Araucanophylus sulinus* Carvalho, 1984

Bol. Mus. Goeldi, Zool. 1(2):158, figs. 20–23; H ♀, Chile, Bio-Bio, El Abanico, XII.30.1950, Ross & Michelbacher; P 4♂♂, 1♀; CAS.

*Archeofulvius singularis* Carvalho, 1966

Rev. Brasil. Biol. 26(2):200, figs. 1–2; H ♀, Baltic amber; A ♀, P 1♂, 1♀; ZM.

*Argyrocoris bellissimus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):80, figs. 14–17 (1973); H ♂, 14 mi. E. Landa de Matamoros, Queretaro, Mexico, July 23–24, 1970, Murray, Phelps, Hart, Schaffner; A ♀, P 1♂; NMNH.

*Aristopeplus rubronotus* Carvalho & Wallerstein, 1977

Rev. Brasil. Biol. 37(1):52, figs. 7–10; H ♂, New Guinea, Papua, Woodlark I. (Murua), Kulumadau Hill, Febr.3.1957, W. W. Brandt, col.; BPBM.

*Aristotelesia carioca* Carvalho, 1947

Rev. Brasil. Biol. 7(2):257, figs. 1–7; H ♂, Guaratiba, D. Federal, Brasil, 14.IX.1941, Aristoteles Silva leg; P 1♂; NM (ex-JCMC).

*Arlemiris roquettei* Carvalho, 1984

Bol. Mus. Goeldi, Zool. 1(2):153, figs. 9–13; H ♂, Ji-Paraná, Rondônia, Brasil, XI.1983, Roppa col.; P 2♂♂; MN.

*Aspidobothrus flavicostus* Carvalho, 1949

Rev. Brasil. Biol. 9(3):325, figs. 19–21; H ♂, Rio Verde, Goiás, Carvalho col. 1944 (em leiteiro), JCMC; A ♀, 12♀♀, 2♂♂; MN (ex-JCMC).

*Aspidobothrus rarus* Carvalho, 1950

An. Acad. Brasil. Ci. 22(1):20, fig. 1; H ♀, Nova Teutônia Santa Catarina, Brasil, Fritz Plaumann col. X.1944; MN (ex-JCMC).

*Aterpocoris usingeri* Carvalho & Becker, 1957

An. Acad. Brasil. Ci. 29(2):286, figs. 1, 3–5; H ♂, Real de Arriba, Temescaltepec, Mexico, July, 12.1933, H. E. Hinton and R. L. Usinger; A ♀, P 1♀; CAS.

*Auchus bellissimus* Knight & Carvalho, 1943

Rev. Brasil. Biol. 3(1):84; H ♀, Pará, Brazil; CM.

*Auchus brasiliensis* Knight & Carvalho, 1943

Rev. Brasil. Biol. 3(1):83; H ♀, Chapada, Brazil; P ♂, ♀; CM.

*Auchus grandis* Carvalho, 1953

Rev. Brasil. Biol. 13(2):197, figs. 1–4; H ♂, Nova Teutônia, S. Catarina, F. Plaumann col.; P ♂; MN (ex-JCMC).

*Auchus schubarti* Carvalho, 1982

Acta Amazon. 12(3):659, fig. 4; H ♂, Brasil, Amazonas, Br. 174, km 153, 14.VI.1977, Norman D. Penny; INPA.

*Austrohyaloma colessi* Carvalho & Gross, 1979

Rec. S. Aust. Mus. 17(30):433, figs. 1–2; H ♀, North Queensland: 16 Km (10 mi) S of Daintree, 25.IV.1967, D. H. Colless; ANIC.

*Azizus basilewskyi* Carvalho, 1951

Rev. Zoo. Bot. Afr. 45(1–2):110, fig. 6g–i; H ♂, Elisabethville, II.1940 (H. J. Bredo coll.); MRAC.

*Aztecariella iarae* Carvalho, 1951

Entomologist 84(1.0061):232, fig. 1; H ♀, Guadalupe, Mexico; BMNH.

*Aztecariina albipes* Carvalho, 1975

Rev. Brasil. Biol. 34(1):47, figs. 6–12 (1974); H ♂, Vera Cruz, Mexico, J.C.M.C. col. III.1970; NMNH (ex-JCMC).

*Baculodema balloui* Knight & Carvalho, 1943



Rev. Brasil. Biol. 3(2):139; H ♀, April 16.1939, road to La Guaira, 20 Kms. outside Caracas, Venezuela (C. H. Ballou); A ♂, P 18♂♂♀; NMNH.

*Bahiamiris cajabianus* Carvalho, 1977

Rev. Brasil. Biol. 37(1):17-18, fig. 1; H ♀, Sinop. Rio Teles Pires, Mato Grosso, Brasil, X.1975, Alvarenga & Roppa col.; MN (ex-JCMC).

*Bahiamiris rubrorrnatatus* Carvalho, 1975

Rev. Brasil. Biol. 35(3):500, fig. 1, 1975; H ♀, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI.1972 Seabra & Roppa; MN (ex-JCMC).

*Bahianisca nigra* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):237, figs. 1-4; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa; P ♂; MN (ex-JCMC).

*Bicurvicoris nigrolineatus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):18, figs. 1-3 (1973); H ♀, 1 mile northwest of Ayutla, Queretaro, Mexico, July 24.1970 taken at light, Murray, Phelps, Hart, Schaffner; A ♂; NMNH.

[*Bilianella minuta*—see under Anthocoridae]

[*Biliola castanea*—see under Anthocoridae]

[*Biliola microscopica*—see under Anthocoridae]

*Biliranian myrmecoides* Carvalho, 1956

An. Acad. Brasil. Ci. 28(2):216, fig. 1; H ♂, Biliran Isl. Philippines, Baker col.; NMNH.

*Bironiella binotata* Carvalho & Lorenzato, 1978

Rev. Brasil. Biol. 38(1):129, figs. 27-31; H ♂, New Guinea: NE Swart, Val., Karubaka, 1450 m, XI.16.1958, light trap, J. L. Gressitt; BPBM.

*Bironiella rubernetata* Carvalho & Lorenzato, 1978

Rev. Brasil. Biol. 38(1):131, fig. 37; H ♀, New Guinea, NE Boden, 100 m, 11 km SE of Oeberfarten, 10.VII.1959, light trap, T. C. Maa col: BPBM.

*Bironiella trinotata* Carvalho & Lorenzato, 1978

Rev. Brasil. Biol. 38(1):132, figs. 38-41; H ♀, New Guinea, NE W. Highlands, Baiver, R. 1150 m, 19.X.1958, J. L. Gressitt col.; A ♂, P 14♀; BPBM.

*Bispinocoris castaneus* Carvalho, 1977

Rev. Brasil. Biol. 37(3):623, figs. 1-5; H ♂, New Guinea (NE), Baidoang, Salawakat Range, 1800 m, 15.IX.1956, B. J. Ford col; BPBM.

*Blesingia elegans* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:49, figs. 76-78, 124; H ♂, Queensland, Beerwah, 24.XI.1964, I. C. Yeo; QM.

*Blesingia gularis* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:47, fig. 121; H ♀, Northern Territory, Warlock Ponds, 23.VIII.1964, T. E. Woodward; QM.

*Blesingia latezonata* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:49, fig. 123; H ♀, Queensland, National Park, 30.V.1929; QM.

*Blesingia tamborinea* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:50, figs. 78-81, 125; H ♂, Queensland, Tamborine Mt., 17.III.1964, G. Monteith; QM.

*Boliviocapsus castaneus* Carvalho & Fontes, 1967

Rev. Brasil. Biol. 27(4):386, figs. 1–5; H ♂, El Palmar, Chaparé, Cochabamba, Bolivia, 100 m, 18.X.1958, Monros & Wygodzinsky; IML.

*Boliviocoris testaceus* Carvalho & Fontes, 1967

Rev. Brasil. Biol. 27(4):389, figs. 6–9; H ♂, Cerro Tunari, Cochabamba, Bolivia, 3,500 m, 23.I.1958, Monros & Wygodzinsky col.; A ♀, P 2♂♂, 9♀♀; IML.

*Borgmeierea alvarengai* Carvalho, 1956

Rev. Brasil. Biol. 16(2):237, figs. 1–2; H ♂, Natal, Rio Grande do Norte, 1.II.52, M.A. Alvarenga col. (associated with *Paratrechina fulva* Mayr); MN (ex-JCMC).

*Bothynotus albonotatus* Carvalho, 1953

Rev. Brasil. Biol. 13(3):268, fig. 5; H ♂, Cordoba, Mexico, Fred K. Knab col; NMNH.

*Bothynotus albus* Carvalho, 1953

Florida Ent. 36(4):161, fig. 1; H ♂, Sarasota Co., Florida, 3.III.1931, W. L. McAtee col.; NMNH.

*Bothynotus caruaruensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):326, figs. 39–42 (1984); H ♂, Caruaru, Pernambuco, Brasil, IV.1972, M. Alvarenga; P 3♂♂; MN.

*Bothynotus castaneus* Carvalho, 1953

Rev. Brasil. Biol. 13(3):269, fig. 6; H ♂, Aguascalientes, Mexico, E. A. Schwarz col.; NMNH.

*Botocodomiris clypeatus* Carvalho, 1979

Rev. Brasil. Biol. 39(2):480, figs. 1–8, H ♂, Reserva Biologica de Sooretama, Estado do Espirito Santo, Brasil, III,1977, JCMC; MN (ex-JCMC).

*Brachyfulvius chapini* Carvalho, 1955

Proc. U.S. Nat. Mus. 103(3337):622, figs. 72, 74a, plate 15, a; H ♀, USNM 61939, Cinchona, Jamaica, May 9, 1941, E. A. Chapin; NMNH.

*Brasiliocarnus bahianus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):380, figs. 4, 6, 8 (1984); H ♂, Estr. Rio bahia, km 965, Motel da Divisa, 960m, Encruzilhada, Bahia, Brasil; P 2♂♂, 1♀; MN.

*Brasiliocarnus incaicus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):381, fig. 11 (1984); H ♀, Peru, Monson Valley, Tingo Maria, XII.11.1954, Schlinger & Ross col.; CAS.

*Brasiliocarnus peruanus* Carvalho, 1985

Reb. Brasil. Biol. 44(3):383, figs. 9, 12, 14 (1984); H ♂, Peru, Onson Valley, Tingo Maria, IX.23.1954; CAS.

*Brasiliomiris ernestoi* Carvalho, 1946

Bol. Mus. Nac. Zool. 72:7, figs. 3, 22–25; H ♂, Viçosa, Minas Gerais, abril, maio e junho de 1944, Fazenda Zeca Lopes (Ernesto C. Dias col.) A ♀, P 2♂♂, 7♀♀; MN (ex-JCMC).

*Bromeliaemiris gressitti* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:55, fig. 75; H ♀, New Guinea, Neth., Ifar, 300–600 m, June 22, 1959, J. L. Gressitt; BPBM.

*Bromeliaemiris morobensis* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:56, figs. 69–74; H ♂, New Guinea, NE, Wau, Morobe, 1200 m, 1–10.V.1963, J. Sedlacek; P 1♂; BPBM.

*Bromeliaemiris rubrinus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:57, figs. 76–80; H ♂, New Guinea, Neth., Biak I. Mangrowawa, 50–100 m, V.30.1959, T. C. Maa; BPBM.

*Brycorella emboliata* Carvalho, 1956

Ins. Micronesia 7(1):23, figs. 13, 14d–f; H ♂, Mt. Tafeyat, Kusaie, Aug. 20.1946, H. K. Townes; A ♀, P 1♂, 1♀; NMNH.

*Brycorellisca novaguineae* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:57, fig. 81; H ♀, New Guinea, Neth. Holandia area, W. Sentani, Cyclops Mt., 150–250 m, June 22, 1959, T. C. Maa, sweeping; BPBM.

*Brycorellisca pallidoembiolata* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:58, figs. 82–85; H ♂, New Guinea, Wau, Hospital Ck., 1200 m, 22.V.1965, J. Sedlacek; BPBM.

*Brycorellisca pilosa* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:58, fig. 86; H ♀, New Guinea, NE, Bubia, Markham, V., 50 m, Sept. 17, 1955, J. L. Gressitt; BPBM.

*Bunsua brycoroides* Carvalho, 1951

Rev. Zool. Bot. Afr. 45(1–2):106, fig. 2; H ♂, Gold Coast, Tafo, 5 Jan. 1943 (H. D. Box coll. H. 250); A ♀, P 6 “specimens”; BMNH.

*Bunsua congoana* Carvalho, 1951

Rev. Zool. Bot. Afr. 45(1–2):107; H ♀, Rutshuru, 23.II.1938 (J. Ghesquiere coll.); MRAC.

*Cainganga antennata* Carvalho & Becker, 1957

Rev. Brasil. Biol. 17(2):198, fig. 1; H ♂, Nova Teutônia, Santa Catarina, Brasil, August, 30.1935, Fritz Plaumann; MN (ex-JCMC).

*Callichila emboliata* Carvalho & Schaffner, 1976

Rev. Brasil. Biol. 35(4):711–712, figs. 10–13 (1975); H ♂, Nicar.: Matagalpa, 2 mi. w., VII.23.65, C. Slobodchikoff col. (CIS); CAS.

*Callichila nigrolineata* Carvalho & Schaffner, 1976

Rev. Brasil. Biol. 35(4):712–713, fig. 14 (1975); H ♀, Mexico, Puebla, 4.3 mi. SE. Las Peñas, 20.VIII.1969, 4800, U. Kansas Mex. Exped. (KU); SCUK.

*Callichila pueblensis* Carvalho & Schaffner, 1976

Rev. Brasil. Biol. 35(4):716, figs. 23–26 (1975); H ♂, 3 mi. E. San Hipolito, Pueb., Mexico, VII.30.1962, D. H. Janzen col. (CIS); P 2♂♂; CAS.

*Callichilella seabrai* Carvalho & Fontes, 1968

Rev. Brasil. Biol. 28(1):29, fig. 1; H ♀, Corcovado, GB. Brasil, 26.XI.1965; Alvarenga & Seabra; MN (ex-JCMC).

*Campylomma boharti* Carvalho, 1956

Ins. Micronesia 7(1):33, fig. 20f; H ♂, Chichi Jima, Bonin Is., July 10.1951, R. M. Bohart; NMNH.

*Campylomma boninensis* Carvalho, 1956

Ins. Micronesia 7(1):34, fig. 20j; H ♂, Chichi Jima Bonin Is., July 10.X.1951, R. M. Bohart; P ♂; NMNH.

*Campylomma carolinensis* Carvalho, 1956

Ins. Micronesia 7(1):36, fig. 20l; H ♂, Mt. Teroken, north Moen I., Feb.6.1953, J. L. Gressitt; A ♀, P 3♂♂, 3♀♀; NMNH.

*Campylomma chichijima* Carvalho, 1956

Ins. Micronesia 7(1):36, fig. 20g; H ♂, Fukurozawa, Chichijima, Bonin Is., Aug.6.1935, H. Ikeda; A ♀, P ♀; ECKU.

*Campylomma citrina* Carvalho, 1968

Proc. California Acad. Sci., Fourth Ser. 36(7):156, figs. 7–8; H ♂, Galápagos Archipelago, Bella Vista, Santa Cruz Island, 2.IV.1964 (Usinger); A ♀, P 3♀♀; CAS.

*Campylomma innotata* Carvalho, 1956

Ins. Micronesia 7(1):37; H ♂, Koror, Palau Is., at light, April 25, 1953, J. B. Beardsley, A ♀, P ♀; NMNH.

*Campylomma kororensis* Carvalho, 1956

Ins. Micronesia 7(1):37, fig. 20a; H ♂, Koror, Palau Is., Mar.23.1953, J. W. Beardsley; A ♀; NMNH.

*Campylomma palauana* Carvalho, 1956

Ins. Micronesia 7(1):38, fig. 20h; H ♂, southwest Koror, Palau Is., light trap, Dec. 5, 1952, J. L. Gressitt; P 2♂♂; NMNH.

*Campylomma palauensis* Carvalho, 1956

Ins. Micronesia 7(1):38, fig. 20b; H ♂, Koror, Palau Is., Nov.30.1974, H. S. Dybas; A ♂, P 2♂♂; NMNH.

*Campylomma ponapensis* Carvalho, 1956

Ins. Micronesia 7(1):39, fig. 20d; H ♂, Agric. Exper. Sta., Colonia, Ponape, Jan. 6, 1953, J. L. Gressitt; A ♀, P 3♂♂; NMNH.

*Campylomma ulithiensis* Carvalho, 1956

Ins. Micronesia 7(1):40, fig. 20n; H ♀, Falalop. I., Ulithi Atoll, Western Caroline Is., Apr. 30, 1952, J. W. Beardsley; A ♂, P 2♂♂, 7 ♀♀; NMNH.

*Campylomma yapensis* Carvalho, 1956

Ins. Micronesia 7(1):40, figs. 20i, 21; H ♂, Dugor-Rumu, Yap, 10 m., Nov.29.1952, J. L. Gressitt; A ♀, P 18♂♂, 9♀♀; NMNH.

*Carassacoris caracensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):323, figs. 31–34 (1984); H ♀, Serra do Caraça, Minas Gerais, Brasil, F.M. Oliviera, II.1971; MN.

*Carinimiris lustrosus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:59, fig. 87; H ♀, New Guinea, NE, Goroka, Kabebe, 1800 m, 24.VI.1955, J. L. Gressitt; P 1; BPBM.

*Carmelinus paraensis* Carvalho, 1984

Rev. Brasil. Biol. 44(1):47, figs. 1–7; H ♀, Belém, Pará, Mendes col., V.78; P ♂; MN (ex-JCMC).

*Carmelinus pilosicornis* Carvalho & Gomes, 1972

Rev. Brasil. Biol. 32(1):102, fig. 2; H ♀, Rio Gurupi, Pará, 9.IV.1963, B. Malkin col.; MN (ex-JCMC).

*Carmelus elongatus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):63, figs. 5–9 (1973); H ♂, Costa Rica, San José, 8.3 mi. San Isidro del General, 30 June, 1972, R. R. and M. E. Murray; A ♀, P 1♂, 2 ♀♀; NMNH.

*Caulotops figueiredoi* Carvalho, 1944

Rev. Brasil. Biol. 4(2):243, figs. 1–5; H ♂, Maricá, Set., 1942 Figueiredo Jr. col.; P 9♀♀, 6♂♂, 3 nymphs; MN (ex-JCMC).

*Caulotops nigrus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):268, figs. 5–9 (1984); H ♀, Harry Brailowski col., Cinegullas, Oaxaca, Mexico, 18.X.78; P 1♂, 1♀; UNAM.



*Caulotops tibiopallidus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):268, fig. 10 (1984); H ♀, San Luis Potosi, SLP, Mexico, Br. Trx 81268, XI.2.59 on *Nolina* seed; UNAM.

*Caulotops rufoscutellatus* Carvalho, 1948

Rev. Brasil. Biol. 8(4):530, 4 figs. 11–14; H ♂, Los Teques, Venezuela, 14.III.1948, C. H. Ballou col.; A ♀, P 2♂♂♀; NMNH.

*Caulotops rufoscutellatus major* Carvalho, 1948

Rev. Brasil. Biol. 8(4):532, figs. 15–16; H ♂, Merida, Yucatan, E. J. Hambleton, 13.IX.1946; A ♀, P 1♂; NMNH.

*Cearana nordestina* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):134, figs. 1–2 (1973); H ♀, Ceará, Baturité, XII.1961, JCMC col.; NM (ex-JCMC).

*Ceratocapsisca cuiabana* Carvalho & Wallerstein, 1976

Rev. Brasil. Biol. 35(4):626, figs. 1–7, 32–34 (1975); H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; A ♀; MN (ex-JCMC).

*Ceratocapsella chiapaneca* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33 (Supl.):77, figs. 4–7 (1973); H ♂, Mexico, Chiapas, 10 mi. W. San Cristobal, July 10, 1971, Hart, Murray, Schaffner; P 1♂, NMNH.

*Ceratocapsella longicuneata* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):76, figs. 1–3 (1973); H ♂, C. Zontehuitz, 10 mi. NE. San Cristobal, 9000', Chis., Mex., 21.VI.1965, Burke, Meyer, Schaffner; NMNH.

*Ceratocapsella minor* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):79, figs. 8–13 (1973); H ♂, Mexico, Chiapas, 12 mi. N. Ocozocoautla, July 10.1971, taken at light, Clark, Murray, Hart, Schaffner; A ♀, P 1♂; NMNH.

*Ceratocapsus amapaensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:9, figs. 10–12, 143–144; H ♂, Rio Cassiporé, Amapá, Brasil, 8/9.1961, J. & B. Bechyné; P 3♀♀; MN (ex-JCMC).

*Ceratocapsus amazonensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:10, figs. 13–15; H ♂, Igarapé Tacana, Solimões Rivet, Amazonas, Brazil, Feb. 1962, Candido & Dryce; P 1♂; MN (ex-JCMC).

*Ceratocapsus argentinus* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:10, figs. 16–18; H ♂, Rio Negro, Choele Choele, Argentina, Nov. 1946; MLP (ex-JCMC).

*Ceratocapsus bahiensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:11, figs. 19–21, 145–146; H ♂, Estrado Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brazil, Nov. 1972, Seabra & Roppa; P 2♂♂, 15♀♀; MN (ex-JCMC).

*Ceratocapsus bolivosara* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:12, figs. 25–27; H ♂, Bolivia, Sara Province, Steinbach; P 2♂♂, 1♀; NMNH (ex-JCMC).

*Ceratocapsus catarinensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:13, figs. 31–33; H ♂, Nova Teutonia, Santa Catarina, Brazil, 21°11' N, 52°23' W, Oct.1970, Fritz Plaumann; P 2♂♂; MN (ex-JCMC).

*Ceratocapsus corcovadensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:14, figs. 37–39; H ♂, Corcovado, Guanabara, Brazil, Oct.1970, C. A. Seabra; P 1♂, 1♀; MN (ex-JCMC).

*Ceratopsus cordobensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:15, figs. 40–42; H ♂, Cordoba, Argentina, Calamuchita Dept. “El Sauce”, Dec.1938, Manuel J. Viana; MLP (ex-JCMC).

*Ceratopsus diamantinensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:16, figs. 44–46; H ♂, Diamantino, Fazenda São João, Mato Grosso, Brazil, Km 20, Br 163, Roppa; MN (ex-JCMC).

*Ceratopsus dispersus* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:16, figs. 47–49, 147–148; H ♂, Piura, Peru, June 1943, Borry; P 3♂♂, 2♀♀; NMNH (ex-JCMC).

*Ceratopsus emboabanus* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:17, figs. 50–52; H ♂, Brazil, Minas Gerais, Carmo do Rio Clara, Jan.1978, Carvalho & J.C. Schaffner; MN (ex-JCMC).

*Ceratopsus graziae* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:19, figs. 59–61; H ♂, Paraguay, Horqueta, 1938, Alperdo Schulze coll.; P 1♀; NMNH (ex-JCMC).

*Ceratopsus guanabarinus* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:19, figs. 62–64; H ♂, Corcovado, Guanabara, Brazil, 15 Sept.1967, Alvarenga & Seabra; MN (ex-JCMC).

*Ceratopsus guaraniensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:20, figs. 65–67, 153–154; H ♂, Jacaré, Mato Grosso, Brazil, Parque Xingu, Nov. 1965, Alvarenga; P 7♂♂, 22♀♀; MN (ex-JCMC).

*Ceratopsus guaratibanus* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:21, figs. 68–70; H ♂, Federal District, Guaratiba, Brazil, Nov.1945, Carvalho; MN (ex-JCMC).

*Ceratopsus guianensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:21, figs. 71–73; H ♂, Paramaribo, Suriname, Apr.1961, P. H. van Doesburg, Jr.; P 1♂, 1♀; NMNH (ex-JCMC).

*Ceratopsus itaguaiensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:22, figs. 5, 74–76, 155–156; H ♂, Estrada Rio-São Paulo, Brazil, Km 47, Feb.1945, Wygodzinsky; P 5♂♂, 10♀♀; MN (ex-JCMC).

*Ceratopsus londrinensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:23, figs. 80–82; H ♂, Londrina, Paraná, Brazil, Marc.1975, M. Alvarenga; MN (ex-JCMC).

*Ceratopsus mariliensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:23, figs. 83–85; H ♂, Marília, São Paulo, Brazil, 29 Mar. 1947, H. F. Sauer; P 2♂♂; MN (ex-JCMC).

*Ceratopsus minensis* Carvalho & Fontes, 1983

U.S. Dept. Agric. Tech. Bull. 1676:24, figs. 3, 89–91, 159–160; H ♂, Parque Estadual, Rio Doce, Minas Gerais, Brazil, Apr.1978 (lot no. 21-102), M. A. Vulcano & F. Pereira; P ♂♂, 1♀; MN (ex-JCMC).

*Ceratopsus paraguayensis* Carvalho & Fontes, 1983

- U.S. Dept. Agric. Tech. Bull. 1676:25, figs. 92–94, 161–162; H ♂, Paraguay, Horqueta, 1938, A. Schulze; P 12♂♂, 11♀♀; NMNH (ex-JCMC).
- Ceratocapsus parauara* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:25, figs. 95–97; H ♂, Tucurui, Pará, Brazil, M. Alvarenga, MN (ex-JCMC).
- Ceratocapsus platensis* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:27, figs. 4, 98–100, 163–164; H ♂, Argentina, Tigre, Apr. 1943, Carvalho; P 2♂♂, 6♀♀; MLP (ex-JCMC).
- Ceratocapsus riococensis* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:28, figs. 104–106, 165–166; H ♂, Parque Estadual, Rio Doce, Brazil, Apr. 1978 (col. no. 21-102), M. A. Vulcano & F. Pereira; P 2♂♂, 6♀♀; MN (ex-JCMC).
- Ceratocapsus roppai* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:28, figs. 107–109; H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brazil, 2 Sept. 1974, Alvarenga & Roppa; P 1♀; MN (ex-JCMC).
- Ceratocapsus seabrai* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:29, figs. 110–112; H ♂, Encruzilhada, Bahia, Brazil, Seabra & Roppa; MN (ex-JCMC).
- Ceratocapsus sinopensis* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:30, figs. 116–118, 167–168; H ♂, Sinop, 12°31' S, 55°37' W, Br. 163, km 500–600, Mato Grosso, Brazil, 350 m, Roppa & Alvarenga; P 546♂♂♀♀; MN (ex-JCMC).
- Ceratocapsus surinamensis* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:30, figs. 119–121; H ♂, Paramaribo, Suriname, 24 Oct. 1961, P. H. van Doesburg; NMNH (ex-JCMC).
- Ceratocapsus teutonianus* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:31, figs. 6, 125–127, 169–170; H ♂, Brazil, Nova Teutonia, Santa Catarina, 27°11' N, 52°23' W, Apr. 1976, Fritz Plaumann; P 35♂♂, 31♀♀; MN (ex-JCMC).
- Ceratocapsus tucuruiensis* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:32, figs. 128–130; H ♂, Tucurui, Pará, Brazil, Jan. 1979, M. Alvarenga; MN (ex-JCMC).
- Ceratocapsus veraensis* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:32, figs. 131–133, 171–172; H ♂, Vera, Mato Grosso, Brazil, Alvarenga & Roppa; P 2♂♂, 2♀♀; MN (ex-JCMC).
- Ceratocapsus vulcanopereirai* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:33, figs. 134–136, 173–174; H ♂, Parque Estadual do Rio Doce, Minas Gerais, Brazil, Apr. 1978 (col. 21-luz), Vulcano & Pereira; P 7♂♂, 3♀♀; MN (ex-JCMC).
- Ceratocapsus wygodzinskyi* Carvalho & Fontes, 1983  
U.S. Dept. Agric. Tech. Bull. 1676:34, figs. 140–142; H ♂, Rio de Janeiro (Federal District), Brazil, Nov. 1944, Wygodzinsky; MN (ex-JCMC).
- Cheesmaniella clavonigra* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):121, figs. 15–18; H ♂, New Guinea, Neth., Swart Val. W side, 1400–2000 m, XI.19.1958, J. L. Gressitt; P 11♂♂, 1♀; BPBM.
- Cheesmaniella fasciata* Carvalho, 1984

Rev. Brasil. Biol. 44(1):117, figs. 1–5; H ♂, New Guinea, Neth. Waris s. Hollandia, 450–500 m, VIII.1–17.1959, T. C. Maa; P 27♂♂, 32♀♀; BPBM.

*Cheesmaniella nigra* Carvalho, 1984

Rev. Brasil. Biol. 44(1):119, figs. 7–10; H ♀, New Guinea, Neth., Vogelkop, Fak Fak, S coast of Bomberai, 10–100 m, VI.3.1959, T. C. Maa; P 1♂, 4♀♀; BPBM.

*Cheesmaniella notomaculata* Carvalho, 1984

Rev. Brasil. Biol. 44(1):121, figs. 11–14; H ♂, west New Guinea, Vogelkop, Kebar Val., w of Manokvari, 550 m, 4–31.I.1962, L.W. Quate; P 2♂♂, 2♀♀; BPBM.

*Chileaia uretai* Carvalho, 1944

Rev. Ent. R. J. 15(1–2):152, figs. 2, 7; H ♀, Pemehue, Chile, P 1♀, 1♂; NMNH (ex-JCMC).

*Chiloephylus chiloensis* Carvalho, 1984

Bol. Mus. Goeldi, Zool. 1(2):164, figs. 28–33; H ♂, Dalcahue, Chiloe Is., Chile, I.22.62, R. L. Usinger; P 1♀; CAS.

*Chiloxionotus argentinus* Carvalho & Fontes, 1971

An. Acad. Brasil. Ci. 43(3–4):673, figs. 1–4; H ♂, Misiones Argentina, Dep. Concep. Sta. Maria, M. J. Viana, 47802; MLP (ex-JCMC).

*Chiloxionotus bahianus* Carvalho, 1975

Rev. Brasil. Biol. 35(3):555, figs. 5–8; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI. 1972, Seabra & Roppa col; A ♀, P 9♂♂; MN (ex-JCMC).

*Chiloxionotus basiscutellatus* Carvalho, 1949

Rev. Brasil. Biol. 9(3):147, figs. 9–11; H ♂, Corupa (Hansa Humbolt) Sta. Catarina, Brasil, Nov. 1944, A. Muller col, Frank Johnson; MN (ex-JCMC).

*Chiloxionotus bicolor* Carvalho & Fontes, 1971

An. Acad. Brasil. Ci. 43(3–4):675, figs. 9–12; H ♂, Misiones, Argentina, Dep. Concep. Sta. Maria, M. J. Viana, 47806; P 2♂♂; MLP (ex-JCMC).

*Chiloxionotus capixabensis* Carvalho & Fontes, 1971

An. Acad. Brasil. Ci. 43(3–4):676, figs. 13–16; H ♂, Córrego Itá, E. Santo, X. 1954, W. Zikan; MN (ex-JCMC).

*Chiloxionotus cinammomeus* Carvalho & Fontes, 1971

An. Acad. Brasil. Ci. 43(3–4):676, figs. 17–20; H ♂, Brasilien, Nova Teutonia, Santa Catarina, 27°11' S, 52°23' L, 3500 m, Fritz Plaumann, 23.X.1948; MN (ex-JCMC).

*Chiloxionotus isoldae* Carvalho, 1975

Rev. Brasil. Biol. 35(3):557, figs. 9–12; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI. 1972, Seabra & Roppa col; A ♀, P ♂; MN (ex-JCMC).

*Chiloxionotus mesoscutellatus* Carvalho, 1949

Rev. Brasil. Biol. 93(3):146, figs. 1–4; H ♂, Passa Quatro, (915 m). Sul de Minas Gerais, J. F. Zikan col. 12. XII. 1922; A ♀, P 1♀; MN (ex-JCMC).

*Chiloxionotus minensis* Carvalho & Fontes, 1971

An. Acad. Brasil. Ci. 43(3–4):680, fig. 27; H ♀, Minas (Brasil), Machacalis, XII.1954; MN (ex-JCMC).

*Chiloxionotus nigroscutellatus* Carvalho, 1949



- Rev. Brasil. Biol. 9(3):147, figs. 9–12; H ♀, Virgínia (900 m.), Sul de Minas Gerais, 10.XII.1921, (Paracatu), J. F. Zikan col; MN (ex-JCMC).
- Chiloxionotus nigrus* Carvalho & Fontes, 1971  
An. Acad. Brasil. Ci. 43(3–4):682, fig. 33; H ♀, Brasil-Paraná, Ponta Grossa, Camargo Co., XII.38; P 1♀; MN (ex-JCMC).
- Chiloxionotus platytyloides* Carvalho & Fontes, 1971  
An. Acad. Brasil. Ci. 43(3–4):682, fig. 34; H ♀, Brasilien, Nova Teutonia, 27°11' S, 52°23' L, Fritz Plaumann, 300–500 m, 7.X.1949; MN (ex-JCMC).
- Chiloxionotus rubriscutellatus* Carvalho, 1949  
Rev. Brasil. Biol. 9(3):148, figs. 13–15; H ♂, Itatiaya, 700 m, E. do Rio, Brasil, 2.II.1941, J. F. Zikan col.; MN (ex-JCMC).
- Chiloxionotus rubronigrus* Carvalho, 1980  
Rev. Brasil. Biol. 4(2):299, fig. 6; H ♀, Murundu, Campos, R J (Estado do Rio de Janeiro), Brasil, VIII.78, Alvarenga col; MN (ex-JCMC).
- Chiloxionotus sulinus* Carvalho & Fontes, 1971  
An. Acad. Brasil. Ci. 43(3–4):684, fig. 40; H ♀, Misiones, Argentina, Dep. Concep., Santa Maria, M. J. Vianna, 47807; MLP (ex-JCMC).
- Chrysorrhaneis lineatus* Carvalho, 1979  
Rec. S. Austr. Mus. 17(30):436, figs. 11–15; H ♂, Indonesia, Muffin Bay, Irian Jaya, X.5.44, E. S. Ross; P 1♂, 1♀; CAS.
- Clivinema regalisimilis* Carvalho, 1953  
Rev. Brasil. Biol. 13(3):265, fig. 2; H ♂, Etta, Oaxaca, Mexico, 9.1923, E. G. Smyth, Chittenden 13109; A ♀, P 2♂♂, 4♀♀; NMNH.
- Clivinemidea sulina* Carvalho & Gomes, 1970  
Rev. Brasil. Biol. 30(4):596, figs. 1–2; H ♀, Argentina, Mendoza, 1905, Jansen-Haarups, Mus. Helsinki, Loan no. HE 539; MZU.
- Coleopteromiris similans* Carvalho, 1945  
Bol. Mus. Nac., Zool. 59:1, figs. 1–4; H ♀, Campos do Jordão, Estado de São Paulo (1600 m de altitude), Wygodzinsky leg., Marco 1945; MN (ex-JCMC).
- Collaria capixaba* Carvalho & Fontes, 1981  
Experientiae 27(2):14, figs. 1–6, 47; H ♂, Castelo, Espirito Santo, Brasil, XI.1976, M. Alvarenga; P 2♂♂, 3♀♀; MN (ex-JCMC).
- Collaria columbiensis* Carvalho, 1948  
Rev. Gallese. 1(4):12, figs. 1–8; H ♂, Colombia, La Ceja (Ant.), en kikuyo, Jul. 1967, R. Velez; P 4♂♂, 8♀♀; MEFLG.
- Collaria guaraniana* Carvalho & Fontes, 1983  
Experientiae 27(2):16, figs. 7–12, 48; H ♂, Paraná, 1950, Staviarski col; P 3♂♂, 3♀♀; MN (ex-JCMC).
- Collaria husseyi* Carvalho, 1955  
Rev. Chil. Ent. 4:223; H ♀, Carmo do Rio Claro, Minas Gerais, Brazil; P 5♀♀ [misidentified as Uhler's *Collaria explicata* by Carvalho, 1945, Rev. Ent. R. J., 16: 180, fig. 7, who there figured the species]; MN (ex-JCMC).
- Collaria villiersi* Carvalho, 1953  
Bol. Mus. Nac., Zool. 120:3, fig. 1; H ♂, 1946, Tonkoui, C. I., A. Villiers, 20.IX., culture, foret prim et foret second; A ♀, P 5♂♂; IFAN.
- Collesicoris bellissimus* Carvalho & Gross, 1982

- Austr. Jour. Zool. Suppl. Ser. 86:53, figs. 89–92, 127; H ♀, New South Wales, Durras Lake, South Coast, 22.II.1965, D. H. Colless; ANIC.
- Corcovadocola hypophylla* Carvalho, 1948  
Rev. Brasil. Biol. 8(4):194, figs. 1–5; H ♂, Corcovado, Rio de Janeiro, 20.VII.1947, Wygodzinsky col. debaixo de folhas na mata proxima a Paineiras; A ♀, P 1♀; MN (ex-JCMC).
- Corcovadocola itatiaiana* Carvalho, 1980  
Rev. Brasil. Biol. 40(3):435, figs. 1–4; H ♂, Brasil, Rio de Janeiro, Parque Itatiaia, Jan.1978, Carvalho & Schaffner col; MN (ex-JCMC).
- Corcovadocola pilosa* Carvalho, 1948  
Rev. Brasil. Biol. 8(4):528; H ♀, Corcovado, Distrito Federal 20.VII.1947, Wygodzinsky, P 1♀; MN (ex-JCMC).
- Coridromoides carinatus* Carvalho, 1956  
Ins. Micronesia 7(1):55, fig. 30; H ♂, northwest Auluptagel, Palau, alt. 25 m., Dec.13.1952, J. L. Gressitt; NMNH.
- Corizidolon australiense* Carvalho & Gross, 1979  
Rec. S. Aust. Mus. 17(30):437, figs. 16–21; H ♀, Australia, Queensland, Tamborine Mountain, 15.II.68, F. A. Perkins; A ♀, P 6♂♂; QM.
- Crassicolllus bicolor* Carvalho, 1947  
Bol. Mus. Nac., Zool., 83:5, figs. 2, 10–11; H ♂, Botafogo, D. Federal, 20.XII.1945 (Carvalho col.); A ♀, P 4♂♂, 2♀♀; MN (ex-JCMC).
- Crassicolllus vicosensis* Carvalho, 1947  
Bol. Mus. Nac., Zool., 83:5, figs. 12–17; H ♂, Viçosa, M. Gerais. Colecionado na mata do Sr. Zeca Lopes, numa grota umida (abril, 1944, Carvalho col); MN (ex-JCMC).
- Crassicornus hondurensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool., 1(2):166, figs. 34–36; H ♂, Lancetilla, Honduras; NMNH.
- Crassicornus parvus* Becker & Carvalho, 1957  
Rev. Brasil. Biol. 17(3):421, figs. 1, 4, 6, 8; H ♂, Tres Rios Plantation, Gutun Lake, Panama, 1931, T. O. Zschokke; NMNH (ex-JCMC).
- Crassicornus pulchrus* Carvalho, 1945  
Rev. Brasil. Biol. 5(2):305, figs. 1–8; H ♂, Jussaral, Angra dos Reis, Estado do Rio, X.1934 (L. Travassos & S. Lopes col.); A 1♀, P 7♂♂; MN (ex-IEA).
- Crassicornus rondoni* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):168, figs. 37–42; H ♂, Rondônia, Ji-Paraná. Brasil, XI.1983, Roppa Col; MN.
- Crassicornus rubritinctus* Becker & Carvalho, 1957  
Rev. Brasil. Biol. 17(3):423, figs. 2, 3, 7; H ♂, Tres Rios Plantation, Gatun Lake, Panamá, 1931, T. O. Zschokke; NMNH (ex-JCMC).
- Crassiembolius nigrus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:60, fig. 88; H ♀, Papua, Catalina State, 48 km N of Port Morseby, 500 m, Sept.3.1959, T. C. Maa; P 1♀; BPBM.
- Crassiembolius semipallidus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:60, fig. 89; H ♀, New Guinea, Neth., above Ifar, 300–750 m, VI.23.1959, J. L. Gressitt; BPBM.
- Creontiades citrinus* Carvalho, 1968

- Proc. Cal. Acad. Sci., Fourth Ser. 36(7):192, H ♀, Galápagos Archipelago, Tortuga Bay, Santa Cruz: 2.X.1964, *Heliotropium curassavicum* (Kuschel); P 1♀; CAS.
- Creontiades fernandinus* Carvalho, 1968  
Proc. Cal. Acad. Sci., Fourth Ser. 36(7):192, fig. 38; H ♂, Galápagos Archipelago Fernandina, Punta Espinosa, 27–28.II.1964 (Usinger); P 1♂; CAS.
- Creontiades palauensis* Carvalho, 1956  
Ins. Micronesia 7(1):78, fig. 48a–b; H ♂, northeast Koror, Limestone Ridge, Palau, 40 m., Dec. 14. 1952, J. L. Gressitt; A ♀, P 5♂♂, 3♀♀; NMNH.
- Creontiades punctatus* Carvalho, 1968  
Proc. Cal. Acad. Sci., Fourth Ser. 37(7):196; H ♂, Galapagos Archipelago, Santa Cruz; Academy Bay, Darwin Research Station, 8.II.1964 (Schuster); A ♀, P 3♀♀; CAS.
- Creontiades vittatus* Carvalho, 1968  
Proc. Cal. Acad. Sci., Fourth Ser. 36(7):196; H ♂, Galápagos Archipelago, Academy Bay, Santa Cruz: 15.II.1964, light trap (Ashlock); A ♀, P 1♂, 2♀♀; CAS.
- Creontiades yapensis* Carvalho, 1956  
Ins. Micronesia 7(1):81, figs. 47, 48c–e; H ♂, hill behind Yaptown, Yap I., Dec.I.1952, J. L. Gressitt; A ♀, P 2♂♂, 3♀♀; NMNH.
- Cuneocoris foliaceus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):34, figs. 5–8 (1973); H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N [lapsus for S], 52°23' W, October, 1970, Fritz Plaumann; A ♀, P 6♂♂, 10♀♀; MN (ex-JCMC).
- Cuneomiris elongatus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:61, fig. 90; H ♂, New Guinea, NE, U. Watut, SW 1800–2200 m, 2.V.1958, J. L. Gressitt; BPBM.
- Cylapocerus antennatus* Carvalho & Fontes, 1968  
Rev. Brasil. Biol. 28(3):279, figs. 5–8; H ♂, Bolivia, N. Yungas, Caranavi, F. Denier, V.31; NMNH (ex-JCMC).
- Cylapocoris barensis* Carvalho, 1982  
Acta Amazon. 12(4):813, figs. 4–7; H ♂, Brasil, Amazonas, Reserva Ducke, 5.X.1981, J. A. Rafael; P 1♀; INPA.
- Cylapocoris pilosus* Carvalho, 1954  
Proc. Iowa Acad. Sci. 61:508, pl. II, figs. 3–4, 6; H ♂, Iauareté, Alto Rio Negro, Amazonas, J. C. M. Carvalho col., VI.1949; P 1♂; MN (ex-JCMC).
- Cylapocoris sulinus* Carvalho & Fontes, 1971  
Rev. Brasil. Biol. 31(4):486, figs. 2–5; H ♂, Brasilien, Nova Teutonia, 27 11' S 52 23' L, XI.1944, Fritz Plaumann; A ♀, P 2♀♀; MN (ex-JCMC).
- Cylapocoris tiquienseis* Carvalho, 1954  
Proc. Iowa Acad. Sci. 61:508, Pl. II, fig. 1; H ♂, Rio Tiquié, Amazonas, J. C. M. Carvalho col.; A ♀, P 4♂♂, 1♀; MN (ex-JCMC).
- Cylapoides bicolor* Carvalho, 1952  
Rev. Brasil. Biol. 12(3):270, figs. 6, 9; H ♂, British Honduras, Ponta Gorda, Oct. 1935, J. J. White, B. M. 1937; BMNH.
- Cylapoides unicolor* Carvalho, 1952  
Rev. Brasil. Biol. 12(3):271, fig. 10, 1952; H ♀, Oiapoque, Territorio do Amapá, Brasil, J.C.M. Carvalho, col., 1949; MN (ex-JCMC).
- Cylapomorpha pacifica* Carvalho, 1956

- Ins. Micronesia 7(1):15, figs. 7, 8e-f; H ♂, wooded peak southwest of Ulimang, Babelthuap I., Palau Islands H.S. Dybas; A ♀; NMNH.
- Cyrtocapsus andinus* Carvalho, 1954  
Bull. Brook. Ent. Soc. 49(1):14; H ♂, Cañete, Peru, 17.V.1941, C. P. Clausen col. (208), cat. no. 61993; A ♀, P ♂♂♀, various; NMNH.
- Cyrtocapsus grenadensis* Carvalho, 1954  
Bull. Brook. Ent. Soc. 49(1):16, figs. D-G, J; H ♂, Dominica, W. I., R. G. Fennah col., 15.VI.1941, cat. no. 61994; A ♀, P 1♂, 1♀; NMNH.
- Cyrtocapsus guianus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):269, fig. 11 (1984): H ♀, Botanical Garden, Georgetown, British Guiana, Sept.26.1918, Harrold Morrison; NMNH.
- Cyrtocapsus haitianus* Carvalho, 1954  
Bull. Brook. Ent. Soc. 49(1):16; H ♀, Camp. Perrin, Haiti, 1925, W. I. Hoffman col., cat. no. 61995; P 3♀♀; NMNH.
- Cyrtocapsus nanus* Carvalho, 1954  
Bull. Brook. Ent. Soc. 49(1):14; H ♂, Summit, Panamá, C. Z., 9.IX.1946, N. L. H. Krauss col., cat. no. 61992; A ♀, P 3♂♂, 5♀♀; NMNH.
- Cyrtocapsus nordestinus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):270, fig. 12 (1984); H ♀, Juazeiro, Bahia, Brasil, JCMC; MN.
- Cyrtocapsus paraguaiensis* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):271, fig. 13 (1984); H ♀, Reimoser, Paraguay, San Luiz; NMNH.
- Cyrtocapsus xinguanus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):271, figs. 14-17 (1984); H ♂, Confluencia Xingu-Kolune, Mato Grosso, Brasil, 6.47, JMCM; P 6♀♀; MN.
- Cyrtopeltis* (E.) *andinus* Carvalho & Becker, 1958  
Rev. Brasil. Biol. 18(3):335, figs. 1-3; H ♂, Colombia, Cnd., Paramo above Pacho, 25.II.1842, Chapin, no. 663; A ♀; NMNH.
- Cyrtopeltis* (E.) *aristidesi* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):457, figs. 12-17; H ♂, Casa Nova, Pernambuco, Brasil, IV.1974, J. C. M. Carvalho col; A ♀, P 8♀♀, 15♂♂; MN (ex-JCMC).
- Cyrtopeltis* (T.) *hyalinus* Carvalho, 1947  
Bol. Mus. Nac., Zool. 77:16, fig. 8; H ♂, Nova Teutônia, Sta. Catarina (F. Plauermann), VI.1944; A ♀, P 8♂♂, 7♀♀; NM (ex-JCMC).
- Cyrtopeltis* (T.) *infumatus* Carvalho, 1947  
Bol. Mus. Nac., Zool. 77:16, fig. 9; H ♂, Carmo do Rio Claro, M. Gerais, 1945 (Carvalho col.); A ♀, P 13♂♂, 14♀♀; MN (ex-JCMC).
- Cyrtopeltis* (E.) *itaitaianus* Carvalho, 1980  
Rev. Brasil. Biol. 40(3):436, figs. 5-10; H ♂, Brasil, Rio de Janeiro, Parque, Itaitaia, Jan. 1978, Carvalho & Schaffner col.; A ♀, P 16♂♂, 30♀♀; MN (ex-JCMC).
- Cyrtopeltis* (E.) *lysmachiae* Carvalho and Usinger, 1960  
Proc. Haw. Ent. Soc. 17:252, figs. 3, 6, 7; H ♂, trail from Kokee to Kalalu, Kauai, August 5, 1925, *Lysmachia*, O. H. Sweezy collector; A ♀, P 27.
- Cyrtopeltis* (T.) *nigroculatus* Carvalho, 1947  
Bol. Mus. Nac., Zool. 77:15, fig. 7; H ♂, Carmo do Rio Claro, M. Gerais, VI.1943 (Carvalho col.); A ♀, P 7♀♀; MN (ex-JCMC).



*Cyrtopeltis (E.) phyllostegiae* Carvalho and Usinger, 1960

Proc. Haw. Ent. Soc. 17:251, figs. 2, 9; H ♂ Poamoho Trail, Oahu, April 5, 1936, on *Phyllostegia hirsuta*, R. L. Usinger collector; A ♀, P 15; BPBM.

*Cyrtopeltis (E.) quitoensis* Carvalho & Gomes, 1968

An. Acad. Brasil. Ci. 40(4):535, fig. 17; H ♂, Quito, IX.1962, Equador, JCMC col.; NMNH (ex-JCMC).

*Cyrtopeltis (E.) similis* Carvalho, 1947

Bol. Mus. Nac., Zool. 77:18; H ♂, Rio Douro, D. Federal, Brasil (Carvalho col.), 2.V.1946; A ♀, P 2♀♀, 1♂; MN (ex-JCMC).

*Cyrtorhinus neotropicalis* Carvalho, 1954

An. Acad. Brasil. Ci. 26(3-4):425; H ♂, Km 47, Estrada Rio-São Paulo, 12.XI.1943, O. Braga leg.—based in part on redescription of Carvalho's 1945 (Rev. Brasil. Biol. 5:316-317, figs. 1-3) misidentification of "*Cyrtorrhinus*" *costae* (Stål); A ♀, P 3♂♂, 8♀♀; MN (ex-JCMC).

*Cyrtotyloides panamensis* Carvalho & Maldonado, 1982

Rev. Brasil. Biol. 42(3):559, figs. 1-4; H ♂, Barro Colorado I., Canal Zone, 12 Dec.72, D. Engleman; P 25; NMNH.

*Cyrtotylus wygodzinskyi* Carvalho, 1950

An. Acad. Brasil. Ci. 22(1):21, fig. 2 (as "*Cyrtotylus*"); H ♂, Tucumán, Republica Argentina, 21.X.1948, Wygodzinsky col. (na luz); NMNH (ex-JCMC).

[*Cyrtotylus wygodzinskyi*—see *Cyrtotylus wygodzinskyi*]

*Dacerla alata* Carvalho and Usinger, 1957

Wasmann Jour. Biol. 15:7, figs. 7-11; H ♂, Janderanter Flat, San Jacinto Mts., California, June 11, 1940 (C.D. Michner); A ♀, P 1♀; CAS.

*Dagbertus antillianus* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):159, figs. 1-3; H ♂, Lac, 23.V.1957, Bonaire, R. H. Cobben; P 2♂♂, 6♀♀; NMNH (ex-JCMC).

*Dagbertus bahianus* Carvalho, 1975

Rev. Brasil. Biol. 35(3):452, figs. 1-5; H ♂, Joacema, Senhor do Bonfim, Bahia, Brasil, em caatinga, J. C. M. Carvalho col.; A ♀; MN (ex-JCMC).

*Dagbertus bermudensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):160, figs. 4-6; H ♂, Bermuda Is., 5.VII.1910, H.M. Pershley [lapsus for Parshley]; P 1♀; NMNH (ex-JCMC).

*Dagbertus carmelitanus* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):162, figs. 11-14; H ♂, Brasil, Minas Gerais, Carmo do Rio Claro, Jan.1978, Carvalho & Schaffner; P 11♂♂, 13♀♀; MN (ex-JCMC).

*Dagbertus curacaoensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):163, figs. 15-17; H ♂, Sta. Martha, Villa Maria, Ilha Aruba (Curaçao), 4.IV.1957, R. H. Cobben; P 1♂, 1♀; NMNH (ex-JCMC).

*Dagbertus diamantinus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):100, figs. 5-7; H ♂, Diamantino, Faz. S. João, MT (Mato Grosso), Brasil, Km 20 Br 16, Roppa col.; P 2, ♀; MN.

*Dagbertus eustatiuensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):164, figs. 18-20; H ♂, Oranjestad, Lamp., 30.XII.1956, St. Eustatius (Ilha), R. H. Cobben; NMNH (ex-JCMC).

*Dagbertus formosus* Carvalho, 1968

Proc. Cal. Acad. Sci., Fourth Ser. 36(7):207, fig. 49; H ♂, Galápagos Archipelago,

Santa Cruz, Academy Bay, Darwin Research Station, 20.II.1964 (Cavagnaro and Schuster); CAS.

*Dagbertus guaraniensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):165, figs. 21–23; H ♂, Brasil, Minas Gerais, Casa Alpina, Itamonte, Jan.1978, Carvalho & Schaffner; P 3♀♀; MN (ex-JCMC).

*Dagbertus insignis* Carvalho, 1977

Rev. Brasil. Biol. 37(1):18, fig. 2; H ♀, Sinop. Rio Teles Pires, Mato Grosso, Brasil, X.1975, M. Alvarenga & Roppa col.; P 2♀♀; MN (ex-JCMC).

*Dagbertus marmoratus* Carvalho, 1968

Proc. Cal. Acad. Sci., Fourth Ser. 36(7):209, fig. 50; H ♂, Galápagos Archipelago, Floreana: 15.II.1964 (Usinger); A ♀; CAS.

*Dagbertus matogrossensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol., 43(2):166, figs. 27–29; H ♂, Sinop, 12°31' S, 55°37' W, Br 163, Km 500–600, Mato Grosso, Brasil, 350 m, X.1974, Alvarenga & Roppa; P 1♀; NM (ex-JCMC).

*Dagbertus mexicanus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):49, figs. 5–8 (1973); H ♂, 31 mi. SE. Comitan, Chis., Mex., 18.VI.1965, at light, Burke, Meyer, Schaffner; A ♀, P 1♂; NMNH.

*Dagbertus minensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):167, figs. 30–32; H ♂, Brasil, Minas Gerais, Carmo do Rio Claro, Jan.1978, Carvalho & Schaffner; P 1♀; NM (ex-JCMC).

*Dagbertus oaxacensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):168, figs. 33–35; H ♂, Mexico, Oaxaca, 10 mi. N. Miltepec, July 26, 1973, Mastro & Schaffner; NMNH (ex-JCMC).

*Dagbertus obscurus* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):169, figs. 36–38; H ♂, Estr. Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa; P 6♂♂, 6♀♀; MN (ex-JCMC).

*Dagbertus paraensis* Carvalho, 1980

Rev. Brasil. Biol. 4(2):310, figs. 10–13; H ♂, Tucuruí, Pará, Brasil, I.1979, M. Alvarenga, col; P 6♂♂, 18♀♀; MN (ex-JCMC).

*Dagbertus potosianus* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):172, figs. 46–48; H ♂, 2 mi Southeast of Pedro Montoya, S. L. P., Mexico, July 27–28, 1970, Murray, Phelps, Hart, Schaffner; P 1♀; NMNH (ex-JCMC).

*Dagbertus sinopensis* Carvalho & Fontes, 1983

Rev. Brasil. Biol. 43(2):173, figs. 49–52; H ♂, (the last specimen to the right on the card on which it is mounted), Sinop, 12°31' S, 55°37' W. Br 163, Km 500–600, Mato Grosso, Brasil, 350 m, 10.X.74, Alvarenga & Roppa; P 3♂♂, 16♀♀; MN (ex-JCMC).

*Deraeocoris hyalinus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):61, figs. 1–4 (1973); H ♂, 22 mi. W. Toluca, Mex., 16.VII.1966, P. M. and P. K. Wagner; P 1♀; NMNH.

*Deraeocoris indianus* Carvalho, 1957

Arq. Mus. Nac. R. J. 44:67, n.n. for *Deraeocoris indicus* Ballard, 1927, Mem. Dept. Agric. Ind. Ent. 10:61, n. preocc. *Deraeocoris indicus* Poppius, 1915, Ann. Mus. Nat. Hung. 13:74.

*Deraeocoris ponapensis* Carvalho, 1956

Ins. Micronesia 7(1):21, figs. 11c-e, 12; H ♂, Temwetemwenskir, Ponape, 100 m. Jan.II.1953, J. L. Gressitt; A ♀, P 7♂♂, 15♀♀; NMNH.

*Deraeocoris scutellarisana* Carvalho, 1957

Arq. Mus. Nac. R. J. 44:80, n.n. for *Deraeocoris scutellaris* (Reuter, 1871), Rev. d'Ent. 10:133, n. preocc. by *Deraeocoris scutellaris* (Fabricius, 1794) (as *Lygaeus*), Ent. Syst. 4:180.

*Deraeocoris signatoides* Carvalho, 1957

Arq. Mus. Nac. R. J. 44:80, n.n. for *Deraeocoris signatus* (Poppius, 1910) (as *Lamprolygus*), Sjostedt Kilim. Meru Exp. 12(4):47, n. preocc. by *Deraeocoris signatus* Distant, 1904, Ann. Mag. Nat. Hist., Ser. 7 13:274.

*Deraeocoris trukensis* Carvalho, 1956

Ins. Micronesia 7(1):19, figs. 10, 11a-b; H ♂, Civ. Ad. Area, Moen I., Truk, Mar. 10, 1949, R.W.L. Potts; A ♀, 9♂♂, 27♀♀; NMNH.

*Deraeocoris trukensis mariane* Carvalho, 1956

Ins. Micronesia 7(1):19; H ♀, Guam, Mt. Lamlam, Nov. 27, 1952, N. L. H. Krauss; P 1♀; NMNH.

*Derophthalma chilena* Carvalho & Gomes, 1980

Experientiae 26(5):100, figs. 1, 6, 32, 51, 72; H ♂, Chile, Tarapaca, 9.IX.51, Kuschel; P 10♂♂, 3♀♀; NMNH (ex-JCMC).

*Derophthalma corcovadensis* Gomes & Carvalho, 1980

Experientiae 26(5):101, figs. 2, 7, 29, 52, 73; H ♂, Brasil, Rio de Janeiro, Corcovado, X.68, Seabra & Alvarenga col.; P 1♂, 17♀♀; MN (ex-JCMC).

*Derophthalma coriaria* Knight & Carvalho, 1943

Rev. Brasil. Biol. 3(2):140; H ♀, Dec. 1939, Nova Teutônia, Brasil (Fritz Plaumann); P 2♀♀; NMNH.

*Derophthalma costarica* Carvalho & Gomes, 1980

Experientiae 26(5):105, figs. 33, 54, 75; H ♂, Costa Rica, Monte Verde, Provincia de Puntarena, 1.6.74, 1300-1600 m., Barfield; NMNH (ex-JCMC).

*Derophthalma dominicana* Carvalho & Gomes, 1980

Experientiae 26(5):106, figs. 4, 9, 34, 55, 76; H ♂, Republica Dominicana, Provincia de La Vega, 8 millas a oeste de Jayaco, 3.8.67, J. C. Schaffner; P 60♂♂, 36♀♀; NMNH.

*Derophthalma fernandeziana* Carvalho, 1952

Rev. Chil. Ent., 2:24, fig. 2; H ♂, Plazoleta del Yunque, Masatierra, 200m, 9.I.1952, on *Boehmeria excelsa* (Urticaceae), P. G. Kuschel; A ♀, P 6♂♂, 10♀♀; CIE.

*Derophthalma fluminensis* Carvalho, 1944

Rev. Ent. R. J. 15(1-2):148, fig. 6; H ♂, Japuiba, Angra dos Reis, 2-I-1944, Wygodzinsky col.; MN (ex-JCMC).

*Derophthalma guaraniana* Carvalho & Gomes, 1980

Experientiae 26(5):114, figs. 13, 25, 38, 60, 81; H ♂, Brasil, Santa Catarina, Nova Teutônia. 27°11' N [lapsus for S], 52°23' W, 11.71, Fritz Plaumann; P 45♂♂, 84♀♀; MN (ex-JCMC).

*Derophthalma mexicana* Carvalho & Gomes, 1980

Experientiae 26(5):119, figs. 14, 41, 48, 63, 84; H ♂, Mexico, Vera Cruz, 10.4

milhas ao sul de Chiconquiaco, 7.8.76., Jordan, Peigler, Gruetzmacker, R & E Murray, Schaffner; P 32♂, 21♀♀; NMNH.

*Derophthalma minuscula* Carvalho, 1944

Rev. Ent. R. J. 15(1-2):146, fig. 4; H ♂, Piquete, S. Paulo, 29-IX-1941, O. Monte col.; P 2♂; MN (ex-JCMC).

*Derophthalma neotropica* Carvalho & Gomes, 1980

Experientiae 26(5):124, figs. 17, 43, 66, 87, 93; H ♂, Brasil, Santa Catarina, Nova Teutônia, 27°11' N [lapsus for S], 52°23' W, 11.71, Fritz Plaumann; P 26♂, 17♀♀; MN (ex-JCMC).

*Derophthalma peruana* Carvalho & Gomes, 1980

Experientiae 26(5):126, figs. 44, 67, 88; H ♂, Peru, Castellana, ICA, 5.3.71, J. Quinez; P 1♀; NMNH (ex-JCMC).

*Derophthalma reuteriana* Carvalho & Gomes, 1980

Experientiae 26(5):129, figs. 19, 45, 69, 90, 95; H ♂, Brasil, Santa Catarina, Nova Teutônia, 27°11' N [lapsus for S], 52°23' W, XI.70, Fritz Plaumann; P 12♂, 28♀♀; MN (ex-JCMC).

*Derophthalma schaffneri* Carvalho & Gomes, 1980

Experientiae 26(5):130, figs. 20, 47, 70, 91; H ♂, Mexico, Hidalgo, 18 Km, M. Santa Ana, April 18, 1978, J. C. Schaffner; P 19♂, 15♀♀; NMNH.

*Derophthalma tucumana* Carvalho & Gomes, 1980

Experientiae 26(5):131, figs. 21, 46, 71, 96; H ♂, Argentina, Tucumán, 21.10.78, Wygodzinsky, P 10♂, 16♀♀; MLP (ex-JCMC).

[For combinations with “*Diaphinidea*” see *Diaphnidea*]

*Diaphnidia baumottei* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:5, figs. 2, 11 [as “*Diaphinidea*”]; H ♂, Interlagos, São Paulo, 13-XII-1942, Monte col.; A 1♀, P 2♂, 1♀; MN (ex-JCMC).

*Diaphnidea decempunctata* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:7, figs. 4, 6 [as “*Diaphinidea*”]; H ♂, São Pedro dos Ferros, Minas Gerais, IX.1943 (Carvalho col.); A 1♀, P 9♂, 6♀♀; MN (ex-JCMC).

*Diaphnidia montei* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:3, figs. 1, 10 [as “*Diaphinidea*”]; H ♂, Jabaquara, São Paulo, 12.V.1940, O. Monte col.; A ♀, P 15♂, 20♀♀; MN (ex-JCMC).

*Diaphnidia paulistana* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:8, figs. 5, 9 [as “*Diaphinidea*”]; H ♂, Iguarussu, São Paulo, (H. Parker col.); A 1♀, P 2♂, 11♀♀; MN (ex-JCMC).

*Diaphnidea rufoscutellata* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:6, figs. 3, 7 [as “*Diaphinidea*”]; H ♂, Viçosa, Minas Gerais, 8-1943 (Carvalho col.); A ♀, P 4♂, 9♀♀; MN (ex-JCMC).

*Dichroocoris malaisei* Carvalho, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:301, figs. 1-3; H ♂, Oaxaca, Mexico, Salle; NR.

*Dioniza conspurcata* Carvalho, 1945

Rev. Ent. R. J. 16(1-2):160, fig. 1; H ♂, Viçosa, M. Gerais, VI.1944 (Carvalho col.); MN (ex-JCMC). Preocc. in *Phytocoris*, see *Phytocoris brasiliensis*.

*Diplozona dispersa* Carvalho & Gomes, 1972

Rev. Brasil. Biol. 32(1):21, figs. 2-4; H ♀, Tapirapé, M. Grosso X.1960, B. Malkin; A ♂, P 2♂, 1♀; MN (ex-JCMC).



*Diplozona mexicana* Carvalho & Gomes, 1972

Rev. Brasil. Biol. 32(1):23, figs. 5-7; H ♀, Real de Arriba, Temescaltepec, Mex., 27.V.1933, J. E. Hinton, R. L. Usinger collectors; A ♂; NMNH (ex-JCMC).

*Dolichomiris puncticerus* Carvalho, 1975

Rev. Brasil. Biol. 35(1):124, figs. 5-8, 52 (1974); H ♂, Brasilen, Nova Teutônia, 27°11' S, 52°23' W, Fritz Plaumann col. V.1945; A ♀, P 7♂♂, 6♀♀; MN (ex-JCMC).

*Domingomiris coloradensis* Carvalho, 1980

Rev. Brasil. Biol. 40(3):431, figs. 1-6; H ♂, Sto. Domingo de los Colorados, 1962, Ecuador, JCMC col.; P 1♂; NMNH (ex-JCMC).

*Druthmarus congolensis* Carvalho, 1951

Rev. Zool. Bot. Afr. 45(1-2):104, fig. 5A-B; H ♂, Benza Mazola, 13.VI.1911, (R. Mayne coll.); MRAC.

*Duckecylapus duckei* Carvalho, 1982

Acta Amazon. 12(4):811, figs. 1-3; H ♂, Brasil, Amazonas, AM 010, Km 26, Reserva Ducke, 14.II.1978, Jorge Arias; INPA.

*Eccritotarsus aimaranus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):175, fig. 1, 1971; H ♀, Museum Paris, Bolivie, Cochabamba, Germain coll., Noualhier, 1898; NMNH (ex-JCMC).

*Eccritotarsus bolivianus* Carvalho, 1953

An. Acad. Brasil. Ci. 2(4):279, fig. 11; H ♂, Bolivia; Mapiri; A ♀, P 1♂; NMNH (ex-JCMC).

*Eccritotarsus brasiliensis* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):176, figs. 2-5; H ♂, Rio de Janeiro, Brasil, Jacarepaguá, Carvalho col.; A ♀, P 18♂♂, 11♀♀; MN (ex-JCMC).

*Eccritotarsus brevicuneatus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):480, fig. 12; H ♂, Bolivia; A ♀, P 2♀♀; NMNH (ex-JCMC).

*Eccritotarsus carioca* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):177, figs. 6-9; H ♂, Corcovado, Rio de Janeiro, D.F., 1946, JCMC col.; A ♀, P 2♂♂, 2♀♀; MN (ex-JCMC).

*Eccritotarsus chapadensis* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):470; H ♀, Chapada, Brasil; MN (ex-JCMC).

*Eccritotarsus clavinotatus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):484, fig. 16; H ♂, Peru, Callanga; P 1♂; NMNH (ex-JCMC).

*Eccritotarsus colombianus* Carvalho & Maldonado, 1971

Rev. Brasil. Biol. 31(2):178, fig. 10; H ♀, Colombia, La Mesa Cund. 14 Aug. 1965; P 1♀; NMNH (ex-JCMC).

*Eccritotarsus compactus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):485, fig. 17; H ♀, Cochabamba, Bolivia; P 1♀, MZU.

*Eccritotarsus costaricensis* Carvalho, 1966

Rev. Brasil. Biol. 26(3):231, figs. 1-4; H ♂, Cuesta del Macho, San Carlos, Costa Rica, No. 2587, C. H. Ballou, 25.III.1934; A ♀; NMNH.

*Eccritotarsus ecuadorensis* Carvalho, 1966

Rev. Brasil. Biol. 26(3):233, figs. 9-12; H ♀, Pichilingue, Ecuador, X.1.44, E. J. Hambleton; A ♂, P 1♀; NMNH.

*Eccritotarsus ecuadorensis* Carvalho & Gomes, 1969

Rev. Brasil. Biol. 29(2):226, fig. 5; H ♂, Tandapi, 1300/1500 m, VI.1965, L. F. Peña col.; NMNH (ex-JCMC). See *Eccritotarsus paracruciatu*s.

*Eccritotarsus elongatus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):472, fig. 4; H ♂, S. Jose, Costa Rica, H. Schmidt leg., 5.VIII.1911; P 1♂; NMNH (ex-JCMC).

*Eccritotarsus emboabanus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):181, figs. 20–22; H ♂, S. Bocaina, 1660 m, S. J. Barrero, S. P., Brasil, 1.1969, M. Alvarenga col.; A ♀, P 3♂♂, 1♀; MN (ex-JCMC).

*Eccritotarsus embolionigrus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):471, fig. 2; H ♀, San Jose, Costa Rica, 5.VIII.1910, H. Schmidt leg.; NMNH (ex-JCMC).

*Eccritotarsus feioi* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):486, fig. 18; H ♂, Cochabamba, Bolivia, coll. Noualhier, 1898; NMNH (ex-JCMC).

*Eccritotarsus gallegoi* Carvalho, 1984

Rev. Gallesc. 1(4):14, fig. 9; H ♀, Colombia, San Antonio de Prado (Ant.), en maleza, Sept. 1981, G. Morales; P ♀; MEFLG.

*Eccritotarsus guaranianus* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(3):413, figs. 5–9; H ♂, Santa Catarina, Luederwaldt; P 3♂♂; MN (ex-JCMC).

*Eccritotarsus incaicus* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(3):414, fig. 10; H ♀, Peru, Dep. Cuzco, Cajon, Bergland, 1500m, Garlepp S. V., 18.XII.1900; NMNH (ex-JCMC).

*Eccritotarsus insignis* Carvalho, 1966

Rev. Brasil. Biol. 26(3):232, figs. 5–8; H ♂, San Isidro de Coronado, Costa Rica, No. 1264, 8.8.34, on *Erythrina rubrinervia* C. H. Ballou; A ♀; NMNH.

*Eccritotarsus longicuneatus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):183, fig. 27; H ♂, Museum Paris, Bolivie, Cochabamba, Germain coll. Noualhier, 1898; NMNH (ex-JCMC).

*Eccritotarsus nicaraguensis* Carvalho, 1966

Rev. Brasil. Biol. 23(3):234, fig. 13; H ♀, Metagalpa, Nicaragua, Swain, 143, X.4.52, 11611, unident. weeds; NMNH.

*Eccritotarsus octopunctatus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):471, fig. 2; H ♂, Pitangueiras, S. Paulo, 3.VII. 1944, O. Monte leg.; MN (ex-JCMC).

*Eccritotarsus paracruciatu*s Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):184 (at bottom of page), n.n. for *Eccritotarsus ecuadorensis* Carvalho & Gomes, 1969, preocc. *Eccritotarsus ecuadorensis* Carvalho, 1966.

*Eccritotarsus paulistanus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):469, fig. 1; H ♂, S. Paulo, Rio Claro, 8.VII.1944, O. Monte col.; MN (ex-JCMC).

*Eccritotarsus pilosus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):183, fig. 28; H ♀, Museum Paris, Bolivie, Cochabamba, Germain coll. Noualhier, 1898; P 1♀; NMNH (ex-JCMC).

*Eccritotarsus quadrinotatus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):476, fig. 8; H ♂, Cochabamba, Bolivia, coll. Noualhier, 1898; A ♀, P 1♂, 2♀♀; MZU.

*Eccritotarsus quichuanus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):473, fig. 5; H ♂, Cochabamba, Bolivia, col. Noualhier, 1989; NMNH (ex-JCMC).

*Eccritotarsus salvadorensis* Carvalho, 1966

Rev. Brasil. Biol. 26(3):235, figs. 14–17; H ♂, no. 830.8, 4.IV.1957; Los Chorros, Col. Salazar; A ♀, P 1♂, 2♀♀; NMNH.

*Eccritotarsus sculpturatus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):474, fig. 6; H ♂, Cochabamba, Bolivia, coll. Noualhier, 1899; A ♀, P 1♂, 1♀; MZU.

*Eccritotarsus similaris* Carvalho, 1951

Ann. Mag. Nat. Hist., Ser. 12 4(32):172; H ♀, San Geronimo, Guatemala, Champion col.; BMNH.

*Eccritotarsus tumidus* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):478, fig. 10; H ♀ (typographical error as ♂), Cochabamba, Bolivia, coll. Noualhier, 1898; P 1♀; NMNH (ex-JCMC).

*Eccritotarsus tupianus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):184, figs. 29–33; H ♂, S. Paulo, Santos, 25.X.1940, O. Monte col.; P 2♂♂; MN (ex-JCMC).

*Eccritotarsus variabilis* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):185, figs. 34–37; H ♂, Museum Paris, Bolivie, Cochabamba, Germain coll. Noualhier, 1898; A ♀, P 3♀♀; NMNH (ex-JCMC).

*Eglerocoris bahiensis* Carvalho, 1975

Rev. Brasil. Biol. 35(2):453, fig. 6; H ♀, Joacema, Senhor do Bonfim, Bahia, Brasil, IV.1974, em caatinga, J. C. M. Carvalho col.; MN (ex-JCMC).

*Eglerocoris egleri* Carvalho & Fontes, 1972

Rev. Brasil. Biol. 32(2):336, figs. 1–5; H ♂, Brasilien, Nova Teutônia, 21°11' S, 52°23' W, Fritz Plaumann, 25.III.1938; A ♀, P 2♂♂; MN (ex-JCMC).

*Emboliocoris pacaraimensis* Carvalho & China, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:684, figs. 4, 7E–G; H ♂, British Guiana, near Mazaruni Hd., Pakaraima Mts., 1932, J. G. Myers coll., H. 3068; BMNH.

*Englemania lutea* Carvalho, 1985

Rev. Brasil. Biol. 44(3):273, figs. 18–21 (1984); H ♂, Gatun Lake, Panamá. IX.8.31, Tres Rios Plantation, Tozssche; NMNH.

*Englemania panamensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):274, figs. 22–25 (1984); H ♂, Panamá, Fort Amador, Feb., 1964, Ch. Keenan; NMNH.

*Esalquinus piracicabensis* Carvalho, 1980

Rev. Brasil. Biol. 40(3):433, figs. 7–8; H ♂, Piracicaba, São Paulo, X.1978, F. Chagas col.; MN (ex-JCMC).

*Eubatas bahiana* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):264, figs. 2–5; H ♀, Estrada Rio-Bahia, KM 965, Motel de Divisa, 960 Km, Encruzilhada, Bahia, Brasil, X.1972, Seabra & Roppa; A ♂, P 2♀♀; MN (ex-JCMC).

*Eubatas pirapora* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):265, figs. 6–9; H ♂, Pirapora, Minas Gerais, Brasil, XI.1976, Seabra & Roppa; A ♀, P 8♂♂, 7♀♀; MN (ex-JCMC).

*Eurotas brasiliensis* Carvalho & Wallerstein, 1976

Rev. Brasil. Biol. 35(4):629, fig. 9 (1975); H ♀, Sinop, Rio Telles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; MN (ex-JCMC).

*Eurychilella bicolor* Carvalho, 1953

Rev. Brasil. Biol. 13(4):351, figs. 11, 13, 18–19; H ♂, Tamazunchales, Mexico, intercepted at Lar., Tex., 24.III.1952 (on *Philodendron* cuttings); A ♀, P 1♂, 2♀♀, 1 nymph; NMNH.

*Eurychilella carioca* Carvalho, 1985

Rev. Brasil. Biol. 44(3):274, figs. 26–29 (1984); H ♂, Botafogo, Rio de Janeiro, D.F., 30.12.1945, JCMC; P 2♂♂, 4♀♀; MN.

*Eurychilella cinnabarina* Carvalho, 1953

Rev. Brasil. Biol. 13(4):350; H ♀, Brazil (on *Bilbergia*) intercepted at Hoboken, N. J., 29.1940; NMNH.

*Eurychilella fasciata* Carvalho, 1953

Rev. Brasil. Biol. 13(4):349, figs. 5, 7, 20; H ♂, Horsetail Falls, Mexico, intercepted at Lar., Tex., 22.XI.1950 (on elephant ear); A ♀, P 3♂♂, 11♀♀; NMNH.

*Eurychilella nigra* Carvalho & Rosas, 1962

Rev. Brasil. Biol. 22(3):247; figs. 1–6; H ♂, Rio de Janeiro (Paineiras), 4.III.1957, Carvalho & Becker col.; A ♀, P 58♂♂, 61♀♀; MN.

*Eurychilella paracatua* Carvalho, 1985

Rev. Brasil. Biol. 44(3):275, figs. 30–33 (1984); H ♀, Paracatua, MG, Brasil, VII.1960, 80/60, Exp. Formosa; P 15♂♂, 18♀♀; MN.

*Eurychilella rubra* Carvalho, 1953

Rev. Brasil. Biol. 13(4):351, figs. 8–10; H ♀, Porto Bello, Panamá, Mar. 11, E. A. Schwartz col.; A ♂; NMNH.

*Eurychiloides bilobosus* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):463, figs. 5–10; H ♂, Viçosa, Minas Gerais, Brasil, IV.1944, Carvalho col.; A ♀, P 1♂; MN (ex-JCMC).

*Eurychlopterella acutifrons* Carvalho, 1948

Bol. Mus. Nac., Zool. 85:4, figs. 14–16; H ♂, Valparaiso, Chile, IV.1943, Carvalho col.; P 1♂; NMNH (ex-JCMC).

*Euryciptia bromeliae* Carvalho, 1946

Bol. Mus. Nac., Zool. 61:2, figs. 5–8, 17; H ♂, Jacarepaguá, D. Federal, IX.1945, Carvalho col.; A ♀, P 1♂, 5♀♀; MN (ex-JCMC).

*Eustictus goianus* Carvalho, 1952

Bol. Mus. Nac., Zool. 112:3, fig. 2; H ♀, Viçosa, Minas Gerais, Brasil, 9.1943, J. C. M. Carvalho col.; P ♀; MN (ex-JCMC).

*Eustictus roraimensis* Carvalho & Gomes, 1972

Rev. Brasil. Biol. 32(1):21, fig. 1; H ♀, Ireng R. to Roraima, Brazil, Aug.16.1911; MN (ex-JCMC).

*Falconia andina* Carvalho, 1953

Rev. Brasil. Biol. 13(1):35, figs. 3–6; H ♂, Ibarre, Ecuador, Febr.13.1927, S. W. Frost col.; A ♀; NMNH.

*Falconia columbiensis* Carvalho, 1984

Rev. Gallasc. 1(4):15, figs. 10–13; H ♂, Colombia, Caldas (Ant.), Mar., 1974, R. Velez, en maleza; P 3♂♂; MEFLG.



*Falconia minor* Carvalho, 1945

Rev. Ent. R. J. 16(1-2):184, figs. 10, 40-42; H ♂, S. Paulo, Capital, 23.XI.1942 (O. Monte col.); A ♀, P 1♂; MN (ex-JCMC).

*Falconia tupiana* Carvalho, 1948

Rev. Brasil. Biol. 8(2):189, figs. 1-4; H ♂, Parque Nacional, Terezópolis, Wygodzinsky col.; A ♀, P 2♂♂, 12♀♀; MN (ex-JCMC).

*Falconia varicolor* Carvalho, 1945

Rev. Ent. R. J. 16(1-2):182, figs. 9, 37-39; H ♂, Santo Amaro, Sao Paulo, 22.III.1940 (O. Monte col.); A ♀, P 9♂♂, 15♀♀; MN (ex-JCMC).

*Falconiodes peruanus* Carvalho & Gomes, 1972

Rev. Brasil. Biol. 32(2):180, figs. 5-8; H ♂, Pomacochas, 25.VIII.1970, J. Ojeda P. col.; P 1♂; NMNH (ex-JCMC).

*Falconiodes velezangeli* Carvalho, 1984

Rev. Gallese. 1(4):16, figs. 14-17; H ♂, Colombia, Dn. Atias (Ant.), Feb., 1980, R. Velez-Angel; P ♂, 12♀♀; MEFLG.

*Felisacoris ponapensis* Carvalho, 1956

Ins. Micronesia 7(1):24, figs. 14a-c, 15a; H ♂, Hydroelectric Plant, Colonia, Ponape, Aug.9.1946, H. K. Townes; A ♀, P 18♂♂, 29♀♀; NMNH.

*Felisacus adamsi* Carvalho, 1956

Ins. Micronesia 7(1):26, figs. 15b, 17c-e; H ♂, Colonia, Ponape, Aug.20.1946; H. K. Townes; A ♀, P 14♂♂, 12♀♀; NMNH.

*Felisacus minutus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:63, figs. 95-98; H ♂, Bismarck Archipelagus, Manu Island, Momote, 12.XII.1959, T. C. Maa; P 1♂; BPBM.

*Felisacus nigrescens* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:63, figs. 99-103; H ♂, New Guinea, Morobe District, Lake Trist, 1600 m, 21-26.XI.1966, C. A. Samuelson; P 8♂♂, 19♀♀; BPBM.

*Felisacus nigrescens rubrinus* Carvalho, 1981

Arq. Mus. Nac. R. J. 46:64, figs. 104-107; H ♂, New Guinea, NE, Morobe District, Lake Trist, 1600 m, 21-26.XI.1968, C. A. Samuelson; P 1♀; BPBM.

*Felisacus rubricuneus* Carvalho, 1956

Ins. Micronesia 7(1):30, figs. 17a-b; 19a; H ♂, Tafeayat, 300-800 ft., Kusaie, Aug.20.1946, H. K. Townes; A ♀, P 8♂♂, 18♀♀; NMNH.

*Femurocoris spinosus* Carvalho, 1977

Rev. Brasil. Biol. 37(3):626, figs. 6-9; H ♂, New Caledonia, Pouebo, 20m, 15.I.1964, R. Straatman col., light trap; BPBM.

*Florus bolivianus* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):149, fig. 16; H ♀, Museum Paris, Bolivie, Cochabamba, Germain coll. Noualhier, 1898; NMNH (ex-JCMC).

*Florus peruanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):363, fig. 1 (1984); H ♂, Peru, Monson Valley, Tingo Maria, 23.IX.54, Schlinger & Ross col.; P 1♀; CAS.

*Florus vittifrons* Carvalho, 1955

Rev. Brasil. Biol. 15(1):112, figs. 2, 6; H ♂, Barro Colorado Is., Canal Zone, 8.VII.1942, Jas. Zetek col. no. 61972; A ♀, P 1♀; NMNH.

*Florus vittiscutellatus* Carvalho, 1953

- Rev. Brasil. Biol. 13(2):198, figs. 5–7; H ♂, Corcovado, Rio de Janeiro, JCMC col., 1946; A ♀; MN (ex-JCMC).
- Formicomiris tibialis* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 35(2):350, figs. 1–6; H ♂, Mexico, Chiapas, 3mi. s. La Trinitaria, July, 20.1973, Mastro and Schaffner; A ♀; NMNH.
- Frontimiris fossatus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:66, figs. 117–120; H ♂, New Guinea, Neth., Biak Is. Strand, VI.24.1959, T. C. Maa; P 3♂♂, 14♀♀; BPBM.
- Frontimiris nigrifrons* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:67, figs. 121–125; H ♂, New Britain, Gaulin, Gazelle Pen., V.23.1956, J. L. Gressitt; P 3♂♂; BPBM.
- Frontimiris obtusifrons* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:68, figs. 126–129; H ♂, New Guinea, NE, Swart Vall., Karubaka, 1420 m, XI.21.1958, J. L. Gressitt; P 1♀; BPBM.
- Frotaphylus moreirai* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):171, figs. 43–46; H ♀, Estr. Rio Bahia, km 965, Encruzilhada, Bahia, Brasil, 960 m, Seabra & Roppa; P 1♂, 2♀♀; MN.
- Fulvius albonotatus* Carvalho, 1955  
Proc. U.S. Nat. Mus. 103(3337):629, figs. 73, 75c, 76d, f; H ♂, USNM 61943, Barro Colorado Island, Canal Zone, Panamá (on *Heliconia mariae* flowers), June 1940, J. Zetek, no. 4667; A ♀, P 3♂♂, 4♀♀; NMNH.
- Fulvius castaneus* Carvalho, 1955  
Proc. U.S. Nat. Mus. 103(3337):630, figs. 75a, d, 76d, f; H ♂, USNM 61944, Tigambato, Michoacán, Mexico (on orchid), intercepted at Laredo, Tex., Oct.16.1948; A ♀, P 3♂♂, 3♀♀; NMNH.
- Fulvius concolor* Carvalho, 1956  
Ins. Micronesia 7(1):7, figs. 2i–j; H ♂, (US), Koror I. Palau Is., Limestone Ridge, north of inlet, Jan.16.1948, H. S. Dybas; A ♀, P 27♂♂, 19♀♀; NMNH.
- Fulvius ornatifrons* Carvalho, 1955  
Proc. U.S. Nat. Mus. 103(3337):631, fig. 75c; H ♀, USNM 61945, Caracas, Venezuela (on *Cattleya speciosissima*), intercepted at San Francisco, Calif., July 10, 1946; P 2♂♂; NMNH.
- Galapagomiris longirostris* Carvalho, 1968  
Proc. Cal. Acad. Sci., Fourth Ser. 36(7):188, figs. 35–36; H ♂, Galápagos Archipelago, Santa Cruz, Academy Bay, Darwin Research Station, 26.I.1964 (Schuster); CAS.
- Ganocapsinus argentinus* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):48, figs. 8–11; H ♂, Rio Negro, Choele Choel, XI.46; P 1♂, 1♀; MLP (ex-JCMC).
- Ganocapsoides pilosus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):48, figs. 1–4 (1973); H ♂, Mexico, Oaxaca, 11.6 mi West of Jalapa del Marques, July 12, 1971, taken at light, Clark, Murray, Hart, Schaffner; A ♀, P 12♂♂, 6♀♀; NMNH.
- Garainamiris antennatus* Carvalho, 1981  
Rev. Brasil. Biol. 41(3):479, figs. 1–5; H ♂, New Guinea, (NE), Garaina, 550–750 m, 16.I.1968, J. & M. Sedlacek; BPBM.

*Garganus diversicornis* Knight & Carvalho, 1943

Rev. Brasil. Biol. 3(2):144; H ♂, Chapada, Minas Gerais, Brasil; P 6♂♂, 2♀♀; CM.

*Garganus insularis* Carvalho & Becker, 1957

Rev. Brasil. Biol. 17(2):254, figs. 4–8; H ♂, Fernando Noronha Island, May 1954, Lt. M. A. Alvarenga; A ♀, P 1♂, 2♀♀; MN (ex-JCMC).

*Garganus magnus* Carvalho & Gomes, 1969

Rev. Brasil. Biol. 29(2):230, fig. 8; H ♀, Loja, Zamora, 2000/2500m, III.1965, L. F. Peña col.; NMNH (ex-JCMC).

*Gauchocoris sulinus* Carvalho, 1980

Rev. Brasil. Biol. 40(2):300, figs. 7–10; H ♂, Montenegro, Rio Grande do Sul (RS), 29.IX.1977, V. Pitoni col.; P 2♂♂, 1♀; MRS.

*Gaveanus incisuratus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):50, fig. 12; H ♀, Jardim Botânico, Rio de Janeiro, 20.III.1937, D. Mendes col.; MN (ex-JCMC).

*Gonzalezinus pemehuenis* Carvalho, 1984

Bol. Mus. Goeldi, Zool. 1(2):172, figs. 47–50; H ♂, Pemehue (Chile), Gutierrez, II.1.46; P 3♂♂; CAS.

*Gonzalezinus squamosus* Carvalho, 1981

Rev. Brasil. Biol. 41(1):12, figs. 1–4; H ♂, Antumapu, Santiago, 13.XII.1978, G. Barria; P 1♂, 7♀♀; MCHN.

*Grossicoris maculatus* Carvalho, 1973

Rev. Brasil. Biol. 33(4):2, figs. 1–4; H ♂, Malao Village, in bay area, Espirito Santo, New Hebrides, 28.VIII.1971, C. F. Gross, Royal Soc. Percy Sladen Exp.; P 10♂♂; SAM.

*Grossicoris nigroculatus* Carvalho, 1973

Rev. Brasil. Biol. 33(4):3, figs. 5–7; H ♂, Noumea, New Caledonia, A. M. Lea; SAM.

*Guanabarea angrensis* Carvalho, 1948

Rev. Brasil. Biol. 8(4):533, H ♀, Angra dos Reis, Japuhya, 2.I.1945, Wygodzinsky col.; MN (ex-JCMC).

*Guanabarea bicolor* Carvalho and Gomes, 1971

Arq. Mus. Nac. R. J. 54:91, fig. 6; H ♀, Brasilien, Nova Teutônia, 27°11' B, 52°23' L., Fritz Plaumann, 12.IX.1938 (Santa Catarina); P 2♀♀; NM (ex-JCMC).

*Guanabarea bicolor* var. *lutescens* Carvalho and Gomes, 1971

Arq. Mus. Nac. R. J. 54:91.

*Guanabarea costaricensis* Carvalho, 1951

Ann. Nat. Mus. Wien 58:104, fig. 1; H ♂, Costa Rica, La Caja b. San Jose, H. Schmidt coll.; A ♀, P ♂; NM.

*Guanabarea lutescens* Carvalho, 1985

Rev. Brasil. Biol. 44(3):321, fig. 28 (1984); H ♀, Bogata, Colombia, 29.VII.40; NMNH.

*Guanabarea maldonadoi* Carvalho, 1985

Rev. Brasil. Biol. 44(3):320, fig. 27 (1984); H ♀, Puerto Rico, El Yunque, Apr.–June. 1967, J. Maldonado; NMNH.

*Guanabarea panamensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):319, figs. 23–26 (1984); H ♂, Panamá, Cerro Campana,

08°41' N, 90°55' W 900 m, June 24, 73, Erwin & Novel [lapsus for Hevel]; NMNH.

*Guanabarea peruana* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(4):493, fig. 2; H ♀, Peru, Marcapata; NMNH (ex-JCMC).

*Guaramiris amapaensis* Carvalho, 1980

Rev. Brasil. Biol. 40(2):312, figs. 14–15; H ♂, Oiapoque, Amapá, Brasil, IX.1969, JCMC col; P 1♀; MN (ex-JCMC).

*Guarania brasiliiana* Carvalho, 1953

Rev. Brasil. Biol. 13(1):34, fig. 2; H ♀, Campos de Jordão, Est. de São Paulo, Brasil, 1600 mts., 3.1945, Wygodzinsky leg.; MN (ex-JCMC).

*Guarania myrmecomorpha* China & Carvalho, 1951

Entomologist 84(1056):116, fig. 1A–B; H ♀, Uruguay, Montevideo, 19.I.1927 F. & M. Edwards coll., B.M., 1927–63; BMNH.

*Guarania paraguayensis* Carvalho & Hussey, 1954

Occas. Papers Mus. Zool. Mich. 552:10; H ♀, Estancia Primera, Caaguazu District, Paraguay, 29.XII.1931 (R. F. Hussey); P ♀; UMMZ.

*Guianella marmorata* Carvalho, 1946

Bol. Mus. Nac., Zool. 72:5, figs. 2, 8–11; H ♂, Paramaribo, 15.VI.1945, Dr. G. C. Geyskes col, na luz, a noite, montado em balsamo creosotado numa lamina escavada; NMNH (ex-JCMC).

*Guianella nematocera* Maldonado & Carvalho, 1981

Rev. Brasil. Biol. 41(2):389, figs. 1–6; H ♂, Coco Solo Hospital, CZ, Panama, light trap, 12 Nov.1972, D. Engleman; P 2♂♂; NMNH.

*Guianella pilosa* Maldonado & Carvalho, 1981

Rev. Brasil. Biol. 41(2):390, fig. 7; H ♀, Coco Solo Hospital, CZ, Panamá, light trap, 17 Sept.1972, D. Engleman; NMNH.

*Guianella trimaculata* Maldonado & Carvalho, 1981

Rev. Brasil. Biol. 41(2):391, figs. 8–14; H ♂, Coco Solo Hospital, CZ, Panamá, light trap, 12 Nov.1972, D. Engleman; P 2♂♂; NMNH.

*Guianella tuberculifrons* Maldonado & Carvalho, 1981

Rev. Brasil. Biol. 41(2):392, figs. 15–21; H ♂, Las Cumbres, Panamá, 9°06' N, 79°32' W, light trap, 14.IV.1974, Hank Wolda; P 1♂; NMNH (ex-JCMC).

*Guianella vicosensis* Carvalho, 1947

An. Acad. Brasil. Ci. 19(1):105, figs. 4–7; H ♂, Viçosa, Minas Gerais, IX.1943, Carvalho col.; MN (ex-JCMC).

*Guisardinus neoguineanus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):442, fig. 27; H ♀, New Guinea: NE Eliptamin Valley, 1200–1350m, 19–30.VI.1959, W. W. Brandt; BPBM.

*Guisardinus solomonicus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):443, fig. 28; H ♀, Solomon Islands: NW Malaita, Dala, 9.VI.1965, R. Straatman; BPBM.

*Guisardus bogorensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):445, figs. 34–37; H ♀, Indonesia, Java, Bogor, 2.57, O. D. Deputy; A ♂, P 4♀♀; NMNH.

*Guisardus chinensis* Carvalho, 1979



- Rec. S. Austr. Mus. 17(30):446, fig. 38; H ♀, South China, Hianan I. Sam-ah-Kong, Yei, Hsian (District), 30.I.1935, F. K. To, Brit. Mus.; BMNH.
- Guisardus cristovalensis* Carvalho, 1979  
Rec. S. Austr. Mus. 17(30):446, fig. 39; H ♀, Solomon Islands, Guadalcanal, Lame nr. Mt. Tatuve, 300m, 18.V.1960, C. W. O'Brien; A ♀; BPBM.
- Guisardus fasciatus* Carvalho, 1979  
Rec. S. Austr. Mus. 17(30):447, fig. 40; H ♀, Solomon Islands, Guadalcanal, Gold Ridge, 800m, 23.VII.1956, J. L. Gressitt; P 1♀; BPBM.
- Haarupia bahiana* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):139, figs. 36–39 (1973); H ♂, Encruzilhada, Bahia, XI.1972, 960m., Seabra & Roppa col.; P 4♂♂; MN (ex-JCMC).
- Haarupia cuiabana* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):321, figs. 1–7; H ♂, Vera, Mato Grosso, Brasil, Alvarenga & Roppa col.; P 10♂♂; MN (ex-JCMC).
- Haarupia distincta* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):140, figs. 9–16 (1973); H ♂, Brasilien, Nova Teutonia, XI.1944, F. Plaumann col.; A ♀, P ♂; MN (ex-JCMC).
- Haarupia minuscula* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):141, figs. 17–22 (1973); H ♂, S. Paulo, Rancharia, 11.IX.1943, O. Monte col.; P ♂; MN (ex-JCMC).
- Haarupia vittiscutellata* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):322, figs. 8–13; H ♂, Joaçema, Senhor do Bonfim, Bahia, Brasil, IV.1974, em caatinga, J. C. M. Carvalho col.; A ♀, P 2♂♂; MN (ex-JCMC).
- Hadronemella tucumana* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):51, figs. 13–16; H ♂, Tucumán, Argentina, XII.49, Wygodzinsky col.; P 1♂, 2♀♀; MLP (ex-JCMC).
- Hadronemidea corcovadensis* Carvalho & Gomes, 1970  
Rev. Brasil. Biol. 30(4):597, fig. 4; H ♀, Corcovado, XII.1957, C. A. Seabra & M. Alvarenga col.; MN (ex-JCMC).
- Hadronemisca argentina* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(3):523, figs. 1–5; H ♂, Republica Argentina, S. Jeronimo, San Luis, 1972; P 3♂♂; MACN.
- Hadronemisca matogrossensis* Carvalho, 1973  
Rev. Brasil. Biol. 33(1):20, fig. 1; H ♀, Rosário Oeste, MT, XI.1963, M. Alvarenga col.; MN (ex-JCMC).
- Hadronemisca saltensis* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(3):524, figs. 6–9; H ♂, Republica Argentina, Salta, Tacuil, 2,400m, 23–27.I.1968, Golbach, Teran, Willink; P 1♂; IML.
- Haitiana singularis* Carvalho, 1952  
An. Acad. Brasil. Ci. 24(2):181, fig. 1; H ♂, Haiti, XII.1929, Dr. J. G. Myers (H. 134), Pres. by Imperial Institute Entomology; BMNH.
- Hallodapoides guaraniensis* Carvalho, 1951  
Ann. Nat. Hofsm. Wien. 58:106, figs. 2G–H; H ♂, Chaco, Paraguay, Fiebrig; A ♀, P 6♂♂; NM.
- Hambletoniola antennata* Carvalho, 1954  
Ent. News 65(5):126, figs. a, D–E; H ♂, Mexico (Brownsville, Texas), V.5.39, 31903) on *Leucophyllum*, no. 61996; A ♀, P ♂, ♀, nymph; NMNH.

*Harpedona verticicolor* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:72, figs. 141–144; H ♂ Papua, Kokoda, Pitoki, 400 m, III.23.1956, J. L. Gressitt; P 1♀; BPBM.

*Harrisia brailovskyi* Carvalho, 1983

Rev. Brasil. Biol. 43(2):148, fig. 2; H ♀, Costa Rica, Puntarenas, Monteverde, 6–14 June, 1973, 1400–1700 m. M. Erwin & Hevel Central American Expedition; NMNH (ex-JCMC).

*Hekista albicollaris* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:73, figs. 145–149; H ♂, New Guinea, NE, Morobe District, Lake Trist, 1600 m, 21–26.XI.1966, C. A. Samuelson; P 5♂♂, 4♀♀; BPMP.

*Hekista papuensis* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:74, figs. 150–154; H ♂, New Guinea, NE, Wau, 1200–1500 m, IX.2.1966; P 30♂♂, 36♀♀; BPBM.

*Hekista similaris* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:75, figs. 155–157; H ♂, New Guinea, NE, Goroka, Kabole, 1800 m, VII.25.55, J. L. Gressitt; P 27♂♂, 40♀♀; BPBM.

*Hemicerocoris bicolor* Carvalho, 1985

Rev. Brasil. Biol. 44(3):318, figs. 18–22 (1984); H ♀, Finca Los Cerritos, Guatemala, VII.6.1944, E.J. Hambleton; P 1♂, 3♀♀; NMNH.

*Hemicerocoris grandis* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(3):415, fig. 11; H ♀, Guadalajara, McConnel, Mexico; NMNH (ex-JCMC).

*Hemicerocoris rubrovenosus* Carvalho, 1953

Rev. Brasil. Biol. 13(3):269, fig. 7; H ♀, Mor., Mexico, Cuernavaca, III.1945, N. L. H. Krauss; NMNH.

*Hemicerocoris tibiannulatus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(4):494, fig. 3; H ♀, Collection Schild-Burgdorf, Costa Rica, San Carlos; NMNH (ex-JCMC).

*Henicocnemis bolivianus* Carvalho & Fontes, 1972

Rev. Brasil. Biol. 32(4):526, fig. 11; H ♀, Bolivia, Coroico, Museu Paris, coll. Noualhier, 1898; NMNH (ex-JCMC).

*Henicocnemis conspurcatus* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(4):598, figs. 5–8; H ♂, Paraguay, Caaguazu District, Estancia Primera, 9.XII.1931, R. F. Hussey; A ♀; NMNH (ex-JCMC).

*Henicocnemis peruvianus* Carvalho, 1976

Rev. Brasil. Biol. 36(3):716, figs. 2–5; H ♂, Peru, Monson Valley, Tingo Maria, 23.IX.1954, E. I. Schlinger & E. S. Ross col.; A ♀, P 2♂♂; CAS.

*Henicocnemis tucumanensis* Carvalho & Fontes, 1972

Rev. Brasil. Biol. 32(4):531, figs. 2, 20–22; H ♂, Tucumán, Argentina, XII.1949, Wygodzinsky col.; A ♀, P 14♂♂, 6♀♀; MLP (ex-JCMC).

*Herdonisca peruviana* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):136, figs. 3–5 (1973); H ♀, Peru, Yurac, 67 mi. E. of Tingo Maria, 350 m, 10-IV-54, E. I. Schlinger, I. E. S. Ross; CAS.

*Herdonius guaranianus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):149, figs. 5–11 (1973); H ♂, Paraná, Brasil, Stawiarski col., 1950; P 5♂♂; MN (ex-JCMC).

*Herdonius microspinosus* Carvalho & Ferreira, 1974

- Rev. Brasil. Biol. 33(Supl.):151, figs. 12–15 (1973); H ♂, S. Bocaina, 1650m., S. T. Barreiro, SP, Brasil, I.1969, M. Alvarenga col.; P 1♂; MN (ex-JCMC).
- Herdonius vittatus* Carvalho & Ferreira, 1974  
Rev. Brasil. Biol. 33(Supl.):152, figs. 16–17 (1973); H ♂, Missiones, Argentina, Dep. Concep., Santa Maria, M. J. Viana col.; P 2♂♂; MLP.
- Hesperolabops azteca* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):464, figs. 11–15; H ♂, Chapingo, Mex., 12.XI.1961, Jorge Navarro T. coletor; A ♀, P ♂, 3♀♀, 5 abdomenless; NMNH (ex-JCMC).
- Hesperolabops cereus* Schaffner & Carvalho, 1981  
Fol. Ent. Mex. 47:7, fig. 1; H ♂, Mexico, Puebla, 11 mi W Acatlan, July 13, 1974, Murray, Ashe, Schaffner; A ♀, P 16♂♂, 4♀♀; NMNH.
- Hesperolabops murrayi* Schaffner & Carvalho, 1981  
Fol. Ent. Mex. 47:74, fig. 2; H ♂, Mexico, Oaxaca, 10 m N Miltepec, Aug. 4, 1976, Peigler, Gruetzmacher, Murray, Schaffner; A ♀, P 11♂♂, 13♀♀; NMNH.
- Hesperolabops spinosus* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):52, figs. 17–20; H ♂, Mexico, Oaxaca, 15 mi SE Tamaulapan, 6 September, 1972, G. F. & S. Hevel; NMNH (ex-JCMC).
- Hesperolabops zapotitlanensis* Schaffner & Carvalho, 1981  
Fol. Ent. Mex. 47:77, fig. 3; H ♂, Mexico, Puebla, 7 mi S Zapotitlan, Aug. 4, 1976, Peigler, Gruetzmacher, Murray, Schaffner; A ♀, P 11♂♂, 3♀♀; NMNH.
- Horcias (H.) acreanus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):466, figs. 52–62; H ♂, Cruzeiro do Sul, Acre, Brasil, II.1963, M. Alvarenga col.; MN (ex-JCMC).
- Horcias (H.) aspersus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):448, figs. 63–68; H ♂, Sala de Ozo Farm, 21.IV.1938; A ♀; MLP (ex-JCMC).
- Horcias (H.) bahianus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):448, figs. 69–73; H ♂, Encruzilhada, Bahia, X.1972, 960m., Seabra & Roppa col.; A ♀, P 2♂♂, 1♀ ex.; MN (ex-JCMC).
- Horcias (H.) bolivianus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):450, figs. 74–78; H ♀, Vitunare, Chapare, Bolivia, XI.1953, Prosen col.; NMNH (ex-JCMC).
- Horcias (H.) carmelitanus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):451, figs. 79–85; H ♂, Carmo do Rio Claro, M. G. (Minas Gerais), I.1958, Carvalho & Becker col.; A ♀, P 3♂♂, 4♀♀; MN (ex-JCMC).
- Horcias (H.) centralis* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):452, figs. 86–91; H ♂, Panamá, El Vale, Aug. 1945, N. H. L. Krauss; P 1♂; NMNH (ex-JCMC).
- Horcias (H.) guapeanus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):453, figs. 92–96; H ♂, M. Gerais, C. R. Claro (Carmo do Rio Claro) 947, Carvalho col.; A ♀, P 1♂, 2♀♀; MN (ex-JCMC).
- Horcias (H.) hexavittatus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):455, figs. 97–101; H ♂, Colombia, Sasaima, Cundinamarca, Apr.1965, J. A. Ramos col.; P 1♂; NMNH (ex-JCMC).
- Horcias (H.) incaicus* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):435, figs. 15–21; H ♂, Peru, Marcapata; A ♀; NMNH (ex-JCMC).

*Horcias (H.) lineifer* Carvalho, 1976

Rev. Brasil. Biol. 36(2):457, figs. 102–107; H ♂, Chavantina, M. Grosso, 6.1974, J. C. M. Carvalho col.; A ♀, P 22 ex.; MN (ex-JCMC).

*Horcias (H.) minensis* Carvalho, 1976

Rev. Brasil. Biol. 36(2):458, figs. 108–112; H ♂, M. G. (Minas Gerais), Brasil, C. R. Claro, Carvalho col.; P 3♂ ex.; MN (ex-JCMC).

*Horcias (H.) paranaensis* Carvalho, 1976

Rev. Brasil. Biol. 36(2):464, figs. 126–133; H ♂, Nova Teutônia, Brasil, II.4.1935, Fritz Plaumann; P 2♂ ex.; MN (ex-JCMC).

*Horcias (H.) punctatus* Carvalho, 1976

Rev. Brasil. Biol. 36(2):468, figs. 146–151; H ♂, Sinop, Rio Teles Pires, M. T. (Mato Grosso), Brasil, IX.1974, Alvarenga & Roppa col.; A ♀, P 1♂, 1♀; MN (ex-JCMC).

*Horcias (H.) vittatus* Carvalho, 1976

Rev. Brasil. Biol. 36(2):470, figs. 156–160; H ♂, Carmo do Rio Claro, Minas Gerais, I.1958, Carvalho & Becker cols.; A ♀, P 10♂, 3♀♀; MN (ex-JCMC).

*Horciasinus amazonicus* Carvalho, 1976

Rev. Brasil. Biol. 36(4):815, figs. 1–7, 50, 58; H ♂, Amazonas, Brasil, Rio Itacoai, V.50, J.C. M. Carvalho col.; A ♀, P 8 ex.; MN (ex-JCMC).

*Horciasinus nordicus* Carvalho, 1976

Rev. Brasil. Biol. 36(4):821, figs. 22–26, 54, 62; H ♂, Boa Vista, Rio Branco, Brasil, 27.VII.1952, M. Alvarenga col.; A ♀, P 15 ex.; MN (ex-JCMC).

*Horciasinus xavantinus* Carvalho, 1976

Rev. Brasil. Biol. 36(4):832, figs. 48–49; H ♀, S. Rita do Araguaia, Goiás, Brasil, XI.1963, Alvarenga & Werner col.; A ♂, P 1♂, 3♀♀; MN (ex-JCMC).

*Horciasisca castanea* Carvalho, 1976

Rev. Brasil. Biol. 36(1):100, figs. 1–6; H ♂, Carmo Rio Claro, M. G., I.1958, Carvalho & Becker col.; A ♀, P 5♂, 1♀; MN (ex-JCMC).

*Horciasisca ecuadorensis* Carvalho, 1976

Rev. Brasil. Biol. 36(1):103, figs. 15–19; H ♂, Tandapi, 1300–1500m, VI.1965, Ecuador, L. F. Peña col.; A ♀, P 4♂, 3♀♀ ex; NMNH (ex-JCMC).

*Horciasisca insignis* Carvalho, 1976

Rev. Brasil. Biol. 36(1):104, figs. 20–24; H ♂, M. G. Brasil, Carmo Rio Claro, 1947, Carvalho col.; A ♀, P 37♂, 40♀♀; MN (ex-JCMC).

*Hyaliodes azteca* Carvalho, 1955

Rev. Brasil. Biol. 15(1):116, figs. 4, 8; H ♂, Cuernavaca, Morelos, Mexico, IV.1945, N. L. H. Krauss, no. 61970; A ♀, P 1♂, 3♀♀; NMNH.

*Hyaliodes beckeri* Carvalho, 1953

Rev. Brasil. Biol. 13(2):113, figs. 1–3; H ♂, Santa Tereza, Rio de Janeiro, J. Becker, VIII.1952; A ♀, P 1♀; MN (ex-JCMC).

*Hyaliodes callani* Carvalho & Drake, 1943

Rev. Brasil. Biol. 3(1):88; H ♀, Diego Martin, Trinidad, B. W. I., 10.I.1940, E. McCallan; DC in NMNH.

*Hyaliodes clarus* var. *hemitestaceus* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:14.

*Hyaliodes clarus* var. *vittiscutellatus* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:14.



*Hyaliodes costaricensis* Carvalho, 1953

Rev. Brasil. Biol. 13(2):115, figs. 4–8; H ♂, S. Izidro, Costa Rica, Bierig col.; A ♀, P 1♀; NMNH (ex-JCMC).

*Hyaliodes ecuadorensis* Carvalho & Gomes, 1968

An. Acad. Brasil. Ci. 40(4):531, figs. 1–4; H ♂, Tandapi, 1300/1500m, L. F. Peña col., Ecuador; P 2♂♂; NMNH (ex-JCMC).

*Hyaliodes guadalupensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):364, fig. 2 (1984); H ♀, Guadeloupe; P 2♀♀; NMNH.

*Hyaliodes hexapunctatus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):364, fig. 3 (1984); H ♀, Colombia, Cundinamarca, Pacho, 2,000 m, Mar.65, J.A. Ramos col.; NMNH.

*Hyaliodes inca* Carvalho, 1955

Rev. Brasil. Biol. 15(1):114, figs. 3, 7; H ♂, Tingo Maria, Peru, 15.IX.1944, E. J. Hambleton col. (on tomato), no. 61971; A ♀, P 1♀; NMNH.

*Hyaliodes intercallosus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):365, fig. 4 (1984); H ♀, Paracatu, MG, Brasil, 7.1960, 36/60, Exp. Formosa; MN.

*Hyaliodes mascarenensis* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):150, figs. 17–20; H ♂, Paradilha, Colombia, 1000m, Cundinamarca, IV.1965, J. A. Ramos; NMNH (ex-JCMC).

*Hyaliodes minensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):367, figs. 5–9 (1984); H ♀, Parque Estadual Rio Doce, Cel. Fabriciano, MG, Brasil, Alvarenga col.; P 1♂; MN.

*Hyaliodes ochraceus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):367, figs. 10–13 (1984); H ♂; Colombia, Villavicencio, Meta, 18 Sept.1985, J. Ramos col.; P 2♂♂, 1♀; NMNH.

*Hyaliodes peruana* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:9, fig. 29; H ♀, Satipo, Peru, P. Paprzyki (O. Monte) leg; A 1♂, P 4♀♀; NMNH (ex-JCMC).

*Hyaliodes quichuanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):369, figs. 14–17 (1984); H ♂, Q. Quinche, 30.4.70, C. Koritkowski col.; P 1♂; NMNH.

*Hyaliodes roraimensis* Carvalho, 1953

Rev. Brasil. Biol. 13(1):37, figs. 7–10; H ♂, H. 3273 Brit. Guiana, Mt. Roraima, 1932, J. G., Myers, 1933.400; BMNH.

*Hyaliodes rubricolor* Carvalho, 1985

Rev. Brasil. Biol. 44(3):370, fig. 18 (1984); H ♀, Corcovado, Guanabara (Rio de Janeiro), Brasil, X.76, C.A. Seabra col; P 3♀♀; MN.

*Hyaliodes sabaensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):370, figs. 19–22 (1984); H ♀, Antilhas, Middle Island, 21.12.1956, Saba, leg. R.H. Cobben; P 2♂♂, 1♀; NMNH.

*Hyaliodes wygodzinskyi* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:21, fig. 33; H ♀, Campinas, São Paulo, 1942 (H. L. Parker col.); A 1♂, P 1♂; MN (ex-JCMC).

*Hyaliodorcoris columbiensis* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):151, fig. 21; H ♀, Colombia, 30 Km W Bogotá, Mosquera, 1800m, III.1965, J. A. Ramos; NMNH (ex-JCMC).

*Hyaliodocoris cundinensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):371, figs. 23–27 (1984); H ♂, Colombia, Alban, Cundinamarca, 10 Sept. 1965, J.A. Ramos col.; P 3♂♂, 10♀♀; NMNH.

*Hyaliodocoris elongatus* Carvalho, 1981

Rev. Brasil. Biol. 41(2):233, figs. 7–11; H ♂, Colombia, 30 Km Bogotá, Mosquera, 1800 m, Mar. 65, J. A. Ramos; P 1♂; NMNH (ex-JCMC).

*Hyaliodocoris explanatus* Carvalho & Gomes, 1968

An. Acad. Brasil. Ci. 40(4):532, figs. 5–6; H ♂, Quito, IX. 1962, Ecuador, JCMC col.; NMNH (ex-JCMC).

*Hyaliodocoris ruberfasciatus* Carvalho, 1945

Bol. Mus. Nac., Zool. 36:28, fig. 38; H ♂, Viçosa, Minas Gerais, VIII. 1943, (Carvalho col); A 1♀, P 2♂♂, 6♀♀; MN (ex-JCMC).

*Hyaliodocoris venezuelanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):373, figs. 33–36 (1984); H ♂, Venezuela, Aragua, Rancho Grande, 20 km of Maracay, El. 1,100 m, 3 August 1976, at light, M.H. Sweet; NMNH.

*Hyaliodocoris vittatus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):372, figs. 28, 32 (1984); H ♀, Colombia, Oak Forest, Osquera, Cundinamarca, 22 May 1965, J.A. Ramos col.; P 1♂; NMNH.

*Hyaliodomiris andina* Carvalho, 1953

Rev. Brasil. Biol. 13(2):117, figs. 9–10; H ♂, Cochabamba, Bolivia, col. Noualhier, 1898; A ♀, P 1♀; NMNH (ex-JCMC).

*Hyalochloria almeidai* Carvalho, 1946

Livro hom. d'Almeida 10:127, figs. 2, 8–10; H ♂, Nova Teutônia, 1944, (Plauermann col.); A ♀, P 3♂♂, 4♀♀; MN (ex-JCMC).

*Hyalopeplinus cairnsensis* Carvalho & Gross, 1979

Rec. S. Austr. Mus. 17(30):454, figs. 53–57, 85; H ♂, Australia, North Queensland (Reg. no. 120,966); A ♀, P 17♂♂, 13♀♀; SAM.

*Hyalopeplinus cristovalensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):455, figs. 58–61, 89; H ♂, Solomon Islands, San Cristoval, Kira Kira, 26.VII.1960, light trap, C. S. O'Brien; A ♀, P 7♂♂, 6♀♀; BPBM.

*Hyalopeplinus fijiensis* Carvalho & Gross, 1979

Rec. S. Austr. Mus. 17(30):456, figs. 62, 87; H ♂, Fiji, Nadarivatu, Viti Levu, 8.II.1968, N. McFarland; P varios ♂♂♀♀; SAM.

*Hyalopeplinus malayensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):457, figs. 63–66, 91; H ♀, Laos, Sedone Prov., Pakson, 18.V.1965, P. D. Ashlock, light trap; A ♂, P 3♀♀; BPBM.

*Hyalopeplinus papuensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):458, figs. 67–70, 84; H ♂, Papua, New Guinea, Abaleti, Rossei Isl., 0.50m, No. 12, 28.IX.1956, Fifth Archibold Exp. to New Guinea, L. J. Brass; A ♀, P 4♂♂; AMNH.

*Hyalopeplinus philippinensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):459, figs. 71–74, 88; H ♂, Philippines, Negros I., Camp Lookout, Dumaguete, 14.5.1961, T. Schneiria, A. Reyes; P 7♂♂♀♀; AMNH.

*Hyalopeplinus solomonensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):462, figs. 79–82, 90; H ♂, Solomon Islands, Florida

Group, Gairava, M'boli passage, Big Nggnela, 13.IX.1960, C. W. O'Brien; A ♀, P 8♂♂, 4♀♀; BPBM.

*Hyalopeploidus alienus* Carvalho & Gross, 1979

Rec. S. Austr. Mus. 17(30):464, figs. 92, 128; H ♀, Australia, North Queensland, Cains District, F. P. Dodd; SAM.

*Hyalopeploidus australiensis* Carvalho & Gross, 1979

Rec. S. Austr. Mus. 17(30):466, figs. 93, 129; H ♀, Australia, Queensland, F. P. Dodd, 1907-54, April, 1904; P 3♀♀; BMNH.

*Hyalopeploidus borneensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):466, figs. 94-97, 132; H ♂, East Malaysia, MT. Kinabalu, Manei Parei, 5000 ft, 5.II.1929, Exp. F. M. S., B. M. 1955-354, H. M. Pendlebury; A ♀, P 1♂; BMNH.

*Hyalopeploidus fasciatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):467, fig. 125; H ♀, Indonesia, Bibidjilan, West Java, M. E. Welsh, 8.V.38; NMNH (ex-JCMC).

*Hyalopeploidus maculatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(3):469, figs. 99-102, 123; H ♀, Indonesia, Swart Val., Karubake, Irian Jaya, 1400-1600m; 9.XI.1958, J. L. Gressitt; A ♂, P 3♀♀; BPBM.

*Hyalopeploidus neoguineanus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):469, figs. 103-107, 126; H ♂, Indonesia, Irian Jaya, Wisselmeren, 1700m, Wagaete, Tigi L., 17.VIII.1955, J. L. Gressitt; A ♀, P 9♀♀; BPBM.

*Hyalopeploidus ochraceus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):471, figs. 108-111, 122; H ♂, New Guinea, Elliptami Valley, 1200-1350m, 1-15.VIII.1959, W. W. Brandt; A ♀; BPBM.

*Hyalopeploidus queenslandensis* Carvalho & Gross, 1979

Rec. S. Austr. Mus. 17(30):472, figs. 112, 131; H ♀, Australia, Kuranda, Qld., VI.1904, F. P. Dodd, B. M. 1907-54; BMNH.

*Hyalopeploidus rubriniscus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):473, figs. 113-116, 134; H ♂, New Ireland, Schleinitz Mts. Lelet Plateau, X.1959, W. W. Brandt; A ♀, P 2♀♀; BPBM.

*Hyalopeploidus rubrinoides* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):473, fig. 127; H ♀, New Britain, Giseluve, Nakanai Mts. 1050m, 26.VII.1956, E. J. Ford Jr.; P 1♀; BPBM.

*Hyalopeploidus similis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):475, figs. 117-120, 124; H ♂, Solomon Islands, Kolombangara, Gollifer's Camp, 700m, 23.I.1964, P. Shanahan; P 1♂; BPBM.

*Hyalopeploidus trinotatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):475, figs. 121, 130; H ♀, New Ireland, Schleinitz Mts., Lelet Plateau, IX.1959, W. W. Brandt; BPBM.

*Hyalopeplus amboinae* Carvalho, 1956

Ins. Micronesia 7(1):74, fig. 44d, f; H ♂, Amboina, F. Muir; A ♀, P 6♂♂, 10♀♀; CAS.

*Hyalopeplus (H.) aneityumensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):479, fig. 135; H ♀, New Hebrides, Aneityum, XI.1930, L. E. Cheesman, B. M. 1931-127; BMNH.

*Hyalopeplus (A.) cuneatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):503, figs. 211–215; H ♂, Indonesia, Waris, S of Hollandia, Irian Jaya, 450–500m, 8–15.VIII.1959; A ♀, P 3♂♂, 3♀♀; BPBM.

*Hyalopeplus (H.) grandis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):480, fig. 137; H ♀, Philippines, MT. Province, Mayayao, Ifugao, 1200–1500m, 9.VIII.1966, H. M. Torrevillas; P 1♀; BPBM.

*Hyalopeplus (H.) hebridensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):482, figs. 143–146; H ♂, New Hebrides, Aneityum, Red Crest, 1200 ft, 3 mi NE of Anelghauhat, VI.1955, L. E. Cheesman, B. M. 1931–1927; A ♀, P 13♂♂♀; BMNH.

*Hyalopeplus (H.) kandanensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):483, fig. 147; H ♀, New Ireland, Kandan, 24.XII.1959, W. W. Brandt; P 1♀; BPBM.

*Hyalopeplus (A.) madagascariensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):505, figs. 221–225; H ♂, Madagascar, Morafenoche, Foret Majesy, 5.52, R. Paulian; NMNH (ex-JCMC).

*Hyalopeplus (H.) malayensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):484, fig. 148; H ♀, Peninsular Malaysia, Pahang, Camerons Highlands, 4800 ft., 26.VI.1945, H. M. Pendlebury, Ex. col. F. M. S. Museum Natural History; P 1♀; BMNH.

*Hyalopeplus (H.) marquesanus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):485, figs. 149–152; H ♀, Marquesas Islands, Mohotni, 300 ft., 4.II.1931, on *Coreopsis* sp., Le Bonnes & H. Tauraa, Pacific Entomological Survey; A ♀, P 2♂♂, 1♀; NMNH.

*Hyalopeplus (H.) nigroscutellatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):487, figs. 154–158; H ♀, New Guinea, SE Popondetta, 60 m, 3–4.IX.1963, J. L. Gressitt; P 5♂♂; BPBM.

*Hyalopeplus (H.) rubroclavatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):490, fig. 170; H ♀, Australia, Cairns, North Queensland, F. P. Dodd, ex-tree; P 2♀♀; BMNH.

*Hyalopeplus (H.) rubrojugatus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):491, figs. 171–175; H ♂, Indonesia, Genjan, 40 Km W of Hollandia, Irian Jaya, 100–200 m, 1.10.1960, T. C. Maa; P 1♂; BPBM.

*Hyalopeplus (H.) tongaensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):495, figs. 182–186; H ♂, Tonga Islands, Eua, Pangai, 90–120 m., III.1969, N. L. H. Krauss; A ♀, P 5♂♂, 9♀♀; BPBM.

*Hyalopeplus (H.) tutuilaensis* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):496, figs. 187–190; H ♂, American Samoa, Tutuila, Taputima, 12.XI.1963, N. R. Spencer; A ♀, P 4♂♂, 6♀♀; BPBM.

*Hyaloplictus minor* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):511, fig. 248; H ♀, Solomon Islands, San Cristovae, Maniate, 6.8.1960, C. W. O'Brien; BPBM.

*Hyaloplictus solomonicus* Carvalho, 1979

Rec. S. Austr. Mus. 17(30):512, figs. 249–252; H ♂, Solomon Islands, Bougainville, Kukugau Vill., 150m, XII.1960, W. W. Brandt; P 1♀; BPBM.

*Icoracicoris bicuspidatus* Carvalho, 1980

Rev. Brasil. Biol. 40(2):313, fig. 16; H ♀, Icoraci, 19.XII.1961, Brasil, Pará, J. & B. Bechyne col.; MN (ex-JCMC).



*Imogen fasciatus* Carvalho, 1983

Rev. Brasil. Biol. 43(4):402, fig. 5; H ♀, Finschafen, New Guinea, V.4.44, E. S. Ross; P 4♀♀; NMNH (ex-JCMC).

*Imogen papuensis* Carvalho, 1983

Rev. Brasil. Biol. 43(4):403, fig. 6; H ♀, Lamington District, Northern Division, Papua, C. T. MacNamara; P 8♀♀; NMNH (ex-JCMC).

*Incacoris nigrisquamosus* Carvalho, 1961

Rev. Brasil. Biol. 21(4):464, figs. 6–9; H ♂, Sicuani, Peru, 3.I.1951, elev. 3000m, Ross & Michelbacher col.; P 1♂; CAS.

*Incafulvius peruvianus* Carvalho, 1976

Rev. Brasil. Biol. 36(3):716, fig. 1; H ♀, Peru, Monson Valley, Tingo Maria, XII.1954, E. I. Schlinger & E. S. Ross coll.; CAS.

*Incamiris peruviansis* Carvalho & Ferreira, 1972

Rev. Brasil. Biol. 32(2):179, figs. 1–4; H ♀, Chriaca, 24.IX.1968, C. Korytkowski col.; A ♂, P 2♀♀; NMNH (ex-JCMC).

*Irazucoris pilosus* Carvalho, 1972

Rev. Brasil. Biol. 32(1):46, fig. 1; H ♀, San Carlos, Costa Rica, collection Schild-Burgdorf; NMNH (ex-JCMC).

*Irianocoris australicus* Carvalho, 1983

Rev. Brasil. Biol. 43(4):404, figs. 7–11; H ♀, Australia, Coen, N. Q., 27.V.51, C. Oke; P 1♂, 1♀; ANIC.

*Irianocoris italiae* Carvalho, 1971

Rev. Brasil. Biol. 31(1):16, fig. 1; H ♀, Maffin Bay, Dutch N. Guinea (W. Irian), 22.VII.1944, E. S. Ross coll.; NMNH (ex-JCMC).

*Isometocoris blantoni* Carvalho & Sailer, 1954

Ent. News 65(4):88, figs. 1–4; H ♂, Pedregoso, Republic of Panama, 28.X.1953, F. S. Blanton (ion light trap), no. 61950; NMNH.

*Itacoris nigrioculus* Carvalho, 1947

An. Acad. Brasil. Ci. 19(1):103, figs. 1, 12–14; H ♂, Corcovado, Rio de Janeiro, D. F., 11.XII.1945, Carvalho col.; P 2♂♂; MN (ex-JCMC).

*Itacoris pugasi* Carvalho, 1953

Rec. Brasil Biol. 13(1):39, figs. 16–20; H ♂, Nova Teutônia, Sta. Catarina, Brasil, F. Plaumann coll., 25.III.1938; A ♀, P 18♂♂♀♀; MN (ex-JCMC).

*Jessopocoris scutellatus* Carvalho, 1981

Rev. Brasil. Biol. 41(3):481, fig. 6; H ♀, Ramikhet, Kumaon, India, H. G. C.; BMNH.

*Jobertus esavianus* Carvalho, 1944

Rev. Ent. R. J. 15(1–2):169, fig. 3; H ♂, Viçosa, ESAV, Minas Gerais, Brasil, Carvalho col.; A ♀, P 5♂♂, 12♀♀; MN (ex-JCMC).

*Jobertus gracilentus* Carvalho & Becker, 1959

An. Acad. Brasil. Ci. 31(1):113, figs. 1, 4–6; H ♂, Carite Mt., Puerto Rico, 2.200 ft., Oct.1947, Caldwell; A ♀; NMNH.

*Joceliana graziae* Carvalho, 1985

Rev. Brasil. Biol. 44(3):361, figs. 1–2 (1984); H ♂, Caraça, Minas Gerais, Brasil, F.M. Oliveira, II.1970; MN (ex-JCMC).

*Jornandinus grandis* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):70, figs. 9–12 (1973); H ♂, Mexico, Oaxaca, 2.7 mi.

- n. w. El Camaron, 14.July.1971, Clark, Murray, Hart, Schaffner; A ♀, P 10♂♂, 22♀♀; NMNH.
- Juarezicoris antennatus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):24, figs. 1–5 (1973); H ♂, Mexico, Oaxaca, 12 mi. W. Tehuantepec, 11.VII.1971, taken at light, Clark, Murray, Hart, Schaffner; A ♀, P 25♂♂, 17♀♀; NMNH.
- Kamaiurana parauara* Carvalho, 1980  
Rev. Brasil. Biol. 4(2):314, fig. 17; H ♀ braquiptera, Caimbé, Vigia, Pará, Brasil, 24.II.1968, J. Barata col., P 1♀; MN (ex-JCMC).
- Kamaiurana xinguensis* Carvalho, 1952  
Rev. Brasil. Biol. 12(3):266, fig. 1; H ♀, confluencia Xingu Koluene, Mato Grosso, Brasil, VI.1947, J. C. M. Carvalho col.; P 1♀; MN (ex-JCMC).
- Knightiella knighti* Carvalho & Drake, 1943  
Rev. Brasil. Biol. 3(1):87; H ♂, Los Baños, Ecuador, 5.VII.1938 (William C. McIntire); A ♀; DC in NMNH.
- Knightonia nigroscutellata* Carvalho, 1981  
Rev. Brasil. Biol. 41(2):232, figs. 1–6; H ♂, Pomacochas, Peru, 25.VII.70, David Ojeda; P 2♂♂; NMNH (ex-JCMC).
- Knightonia peruana* Carvalho, 1953  
An. Acad. Brasil. Ci. 25(2):171, fig. 1; H ♀, Peru, Marcapata; NMNH (ex-JCMC).
- Koluenia kalapalensis* Carvalho, 1952  
Bol. Mus. Nac., Zool. 112:2, fig. 1; H ♂, Koluene, Mato Grosso, 1948, J. C. M. Carvalho col.; P 1♂; MN.
- Krainacoris pilosus* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 35(4):630, figs. 10–15, 35–38 (1975); H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; MN (ex-JCMC).
- Kunungua boxi* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(102):108, fig. 3; H ♂, Gold Coast Amentia, 15.IX.1943 (H. E. Box coll.), on *Aframomum* sp. in primitive forest, H. 1088; A ♀, P 4 “specimens”; BMNH.
- Kunungua cinnamomea* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1–2):109, fig. 5E; H ♀, Kunungua, 2.IV.1921 (Dr. H. Schouteden coll.); MRAC.
- Kuscheliana masatierrensis* Carvalho, 1952  
Rev. Chil. Ent. 2:22, fig. 1; H ♂, El Yunque, Masatierra, 300m, 9.I.1952, P. G. Kuschel; A ♀, P 4♀♀; CIE.
- Lampethusa diamantina* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):102, figs. 11–14; H ♂, Diamantino, Faz. S. Joao, Mato Grosso, Brasil, Km 20, Br 16, Roppa col.; P 2♂♂, 1♀; MN (ex-JCMC).
- Lampethusa tupinambana* Carvalho, 1977  
Rev. Brasil. Biol. 37(1):19, figs. 3–7; H ♂, Corcovado, Rio de Janeiro, Brasil, C.A. Seabra col., X.1975; P 2♂♂; MN (ex-JCMC).
- Lampethusa vianai* Carvalho, 1947  
Bol. Mus. Nac., Zool. 77:6, figs. 3, 23–25; H ♂, Misiones, Argentina, Dept. Concepcion, St. Maria, M. J. Viana col.; A ♀, P 1♀, 1♀; MLP (ex-JCMC).
- Lampsophorus ecuadorensis* Carvalho & Ferreira, 1968

- Rev. Brasil. Biol. 28(2):209, figs. 5–8; H ♂, Malletura, 6.III.1922, Ecuador, G. H. H. Tate collector, elevacion 760; A ♀, P ♀; NMNH (ex-JCMC).
- Lampsophorus peruanus* Carvalho, 1975  
An. Acad. Brasil. Ci. 46(2):306, figs. 9–14 (1974); H ♂, Peru, East side Carpath Mts., 2800m, 40m SW Tingo Maria, 17.X.1954, E. I. Schlinger & E. S. Ross collectors; A ♀, P 4♂♂, 3♀♀; CAS.
- Lasiomiris neoguineanus* Carvalho & Alfonso, 1977  
Rev. Brasil. Biol. 37(4):816, figs. 23–26; H ♂, New Guinea, NE Keglsigl, 2700m, 10.VIII.1969, on grass, J. L. Gressitt; A ♀, P 25 ex.; BPBM.
- Lepidopsallus riocensensis* Carvalho, 1980  
Rev. Brasil. Biol. 40(2):302, figs. 12–15; H ♂, Parque do Rio Doce, Cel. Fabriciano, Minas Gerais, III.78, Alvarenga col.; A ♀, P 8♂♂, 7♀♀; MN (ex-JCMC).
- Leptomiris mexicanus* Carvalho & Becker, 1957  
Rev. Brasil. Biol. 17(2):200, figs. 2–8; H ♂, Real de Arriba, Temescaltepec, Mexico, 7.VI.1933, H. E. Hinton & R. L. Usinger; A ♀, P 4♀♀, 1 ninfā; CAS.
- Lestoniella compacta* Carvalho & Becker, 1957  
An. Acad. Brasil. Ci. 29(2):289, figs. 2, 6–8; H ♀, Real de Arriba, Temescaltepec, Mexico, 12.VII.1933, H. E. Hinton & R. E. Usinger; A ♂, P 2♀♀; CAS.
- Leucophoroptera cavenda* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:37, fig. 115; H ♀, Tasmania, Hobart, Lea; P 2♀♀; SAM.
- Leucophoroptera fasciata* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:38, fig. 116; H ♀, New South Wales, Springwood, 1900, Biro; MZU.
- Leucophoroptera macrozonata* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:39, fig. 117; H ♀, North Queensland, Split Rock, 14 Km S Laura, 23–26.IV.1975, G. B. Monteith; QM.
- Leucophoroptera nitidior* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:38; H ♀, Tasmania, Waldheim, Cradle Mountain, 12–14.II.1967, G. Monteith; P 1♀; QM.
- Leucopocila inornata* Knight & Carvalho, 1943  
Rev. Brasil. Biol. 3(2):141; H ♂, Campinas, São Paulo, Brasil, April 20, 1936 (H. B. Hambleton); P 6♂♂; NMNH.
- Limonia mercedesia* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):268, figs. 1–4 (1984); H ♀, Costa Rica, Egene von Limon, Las Mercedes, 10.11.1921, 150–180 m, 30 km von Atlantik, F. Neumann; P 1♂; NMNH.
- Linacoris viridescens* Carvalho, 1983  
Rev. Brasil. Biol. 43(4):405, figs. 12–15; H ♂, New Guinea, SE Western District, Orinomo R., 3 m, 4.VIII.1964, H. Clissold; P 485♂♂♀; BPBM.
- Lindbergiella aureopilosa* Carvalho, 1951  
An. Acad. Brasil. Ci. 23(4):386, fig. 2c; H ♂, Uganda, Kawanda, III.1944, H. D. Mubiru (on bark of *Abizia stipulata*); A ♀, P 6♀♀, 3♂♂; BMNH.
- Lundiella amazonica* Carvalho & Gomes, 1972  
Rev. Brasil. Biol. 32(1):24, fig. 8; H ♂, Ter. Amapá, Rio Felicio, 19.VII.1965, J. Lane col.; MN (ex-JCMC).

*Lundiella bimaculata* Carvalho, 1952

Bol. Mus. Nac., Zool. 112:4; H ♀, Nova Teutônia, Santa Catarina, Brasil, F. Plaumann col., IX.1944; P ♀; MN (ex-JCMC).

*Lundiella columbiensis* Carvalho & Maldonado, 1982

Rev. Brasil. Biol. 42(1):56, figs. 1–9; H ♂, Colombia, La Mesa, Cundinamarca, 14 August 1965, J. A. Ramos; A ♀, P 51♂♂, 20♀♀; NMNH.

*Lundiella mexicana* Carvalho & Gomes, 1972

Rev. Brasil. Biol. 32(1):25, fig. 9; H ♀, Jalapa, Crawford; NMNH (ex-JCMC).

*Lundiella peruana* Carvalho & Maldonado, 1982

Rev. Brasil. Biol. 42(1):58, figs. 10–13; H ♂, Peru, Monson Valley, Tingo Maria, XII.2.9154, E. J. Schlinger & E. Ross; P 1♀; NMNH (ex-JCMC).

*Lundiella reinhardti* Carvalho, 1951

Ent. Medd. 26:135, figs. 1, 2; H ♂, Rio de Janeiro, Brasil, Reinhardt col.; A ♀, P 2♀♀, 1♂; UZM.

*Lundiella reinhardti plaumanni* Carvalho, 1952

Bol. Mus. Nac., Zool. 112:6; H ♂, Nova Teutônia, Santa Catarina, Brasil, F. Plaumann col., VI-1944, A ♀, P 1; MN (ex-JCMC).

*Lundiella rubra* Carvalho, 1952

Bol. Mus. Nac., Zool. 112:5, fig. 3; H ♀, Fazenda do Penedo, Itatiaia, 500m, 21.XI.1949, Petr Wygodzinsky col.; A ♂, P 1♂, 1♀; MN (ex-JCMC).

*Lygus babelthuapensis* Carvalho, 1956

Ins. Micronesia 7(1):83, fig. 49a–b; H ♂, east Ngatpang, Bebelthuap I., Palau Is., XII.1952, J. L. Gressitt; A ♀, P 1♂, 2♀♀; NMNH.

*Lygus bruneiensis* Carvalho, 1980

Rev. Brasil. Biol. 40(4):654, n.n. for *Lygus rufescens* Poppius, 1914, Ann. Mus. Nat. Hung. 12:378, preocc. *Lygus rufescens* Hahn, 1831, Wanz. Ins. 1:28.

*Lygus dybasi* Carvalho, 1956

Ins. Micronesia 7(1):94, figs. 50e–g, 56; H ♂, Ulimang, Babelthuap I., Palau Is., 25.XII.1947, H. S. Dybas; A ♀, P 14♂♂, 28♀♀; NMNH.

*Lygus kororensis* Carvalho, 1956

Ins. Micronesia 7(1):85, fig. 55a–c; H ♂, Koror I., Palau Is., 30.XI.1947, H. S. Dybas; A ♀, P 3♂♂, 2♀♀; NMNH.

*Lygus kusaiensis* Carvalho, 1956

Ins. Micronesia 7(1):86, fig. 49c–e; H ♂, Mt. Fenkol, Kusaie, 24.I.1953, J. L. Gressitt; A ♀, P 10♀♀, 16♂♂; NMNH.

*Lygus palauensis* Carvalho, 1956

Ins. Micronesia 7(1):87, fig. 51d–f; H ♂, Auluptagel, Palau Is., IX.1952, N. L. H. Krauss; A ♀; NMNH.

*Lygus pitcairni* Carvalho, 1958

Rev. Chil. Ent. 4:224, n.n. for *Lygus insularis* (Van Duzee, 1937), Proc. Cal. Acad. Sci., series 4 22:116, n. preocc. by *Lygus insularis* Reuter, 1895, Rev. Ent. Fr. 14:137.

*Lygus ponapensis* Carvalho, 1956

Ins. Micronesia 7(1):90, figs. 49f–i, 52; H ♂, Colonia, Ponape I., 9.VIII.1946, H. K. Townes; A ♀, P 15♂♂, 19♀♀; NMNH.

*Lygus rotaensis* Carvalho, 1956



Ins. Micronesia 7(1):91, fig. 50a-b; H ♂, Rota Is., 24.VI.1946, H. K. Townes; P 1♂; NMNH.

*Lygus rubrotinctus* Carvalho, 1956

Ins. Micronesia 7(1):91, fig. 51a-c; H ♂, Tapotchau, Saipan I., 6.V.1940, K. Yasumatsu & S. Yoshimura; A ♀; ECKU.

*Lygus sachalinus* Carvalho, 1959

Arq. Mus. Nac. R. J. 48:128, n.n. for *Lygus flavoscutellatus* Matsumura, 1912, Jour. Coll. Agric. Sapporo 4:37, n. preocc. by *Lygus flavoscutellatus* Distant, 1904, Ann. Mag. Nat. Hist., Ser. 7 12:273.

*Lygus saipanensis* Carvalho, 1956

Ins. Micronesia 7(1):92, fig. 49j-k; H ♂, Matansha-Calabera, Saipan I., 3.V.1940, K. Yasumatsu & S. Yoshimura; A ♀, P 1♀; ECKU.

*Lygus trukensis* Carvalho, 1956

Ins. Micronesia 7(1):93, figs. 50c-d, 54; H ♂, Mt. Unibot, Tol. I., Truk, 1.I.1952, J. L. Gressitt; A ♀, P 17♂♂, 45♀♀; NMNH.

*Mabelia columbiensis* Carvalho, 1975

An. Acad. Brasil. Ci. 46(2):307, fig. 15 (1974); H ♀, Colombia, 3 mi W. Villavicencio, mata, 920m, 3.II.1955, E. I. Schlinger & E. S. Ross collectors; CAS.

*Mabelia mexicana* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 34(3):300, figs. 10-13; H ♂, Mexico, Oaxaca, 2 mi N, Totolapan, 17.VII.1973, Mastro & Schaffner; A ♀, P 2♂♂, 11♀♀; NMNH.

*Macrolophus aragarsanus* Carvalho, 1945

Rev. Brasil. Biol. 5(4):530, figs. 13-15; H ♂, Aragarcas, Goias, I.1945 (Carvalho col.); A 1♀; MN (ex-JCMC).

*Macrolophus cuiabanus* Carvalho, 1945

Rev. Brasil. Biol. 5(4):529, figs. 9-12; H ♀, Mato Grossa, Chapada, Brasil; A ♂, P 1♂; MN (ex-JCMC).

*Macrolophus innotatus* Carvalho, 1968

Proc. Cal. Acad. Sci., Fourth Ser. 36(7):167, figs. 18-19; H ♂, Galápagos Archipelago, San Cristóbal, Progreso, 23.II.1964 (Usinger); A ♀, P 2♀♀, 1♂; CAS.

*Macrolophus punctatus* Carvalho, 1968

Proc. Cal. Acad. Sci., Fourth Ser. 36(7):168, fig. 20; H ♂, Galápagos Archipelago, Santa Cruz, E. slope, 160m, 16.III.1964 (Cavagnaro); P 1♂; CAS.

*Macrolophus saileri* Carvalho, 1947

An. Acad. Brasil. Ci. 19(1):106, figs. 3, 15-17; H ♂, Cuerna Vacca, Mexico, XII.1944, em folhagens de *Eupatorium adenophorum*, P. 913, N. L. H. Krauss; A ♀, 5♂♂, P 7♀♀; NMNH.

*Madagascariella longipedes* Carvalho, 1953

Mem. Inst. Sci. Madagascar, Ser. E 3:44, fig. 3; H ♀, Mt. d'Ambre, Madagascar, XII.1949; A ♂, P 1♂; MHNP.

*Mala nigrescens* Carvalho, 1985

Rev. Brasil. Biol. 44(3):293, figs. 99-104 (1984); H ♂, Panamá, C.Z., Fortuna, V.77, H. Wolda col; NMNH.

*Malacocoris elongatus* Carvalho, 1982

Rev. Brasil. Biol. 42(2):313, figs. 5-8; H ♂, Burma, Mishmi Hills, Minutang, 3900 ft, 14.II.1935, M Strele; BMNH.

*Malacocoris indicus* Carvalho, 1982

- Rev. Brasil. Biol. 42(2):311, figs. 1–4; H ♂, Kodai Kanal, S India, T. V. Campbell, B.M. 1926-171; P 1♂, 3♀♀; BMNH.
- Malgacheocoris myrmicoides* Carvalho, 1952  
Mem. Inst. Sci. Madagascar, Ser. E 1(1):97, fig. 2; H ♂, Antsingy, 63 Km a l'Est ole Maintirano, Madagascar, (VII, 49, R. Paulian); MHNP.
- Mansoniella minuta* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:41, figs. 16–19; H ♂, Papua, New Guinea, NE, Ambunti, Sepik R. 200 m, 9.V.63, R. Straatman; BPBM.
- Matogrossia antennata* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):383, fig. 15 (1984); H ♀, Sinop, Br. 163, km 500 a 600, Mato Grosso, Brasil; MN.
- Maxacalinius bahianus* Carvalho, 1976  
Rev. Brasil. Biol. 36(4):760, figs. 1–4; H ♂, Encruzilhada, Bahia, Brasil, Seabra & Roppa col., A ♀, P 1♂, 1♀; MN (ex-JCMC).
- Maxacalinius cuiabanus* Carvalho, 1976  
Rev. Brasil. Biol. 36(4):762, figs. 5–8; H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, M. Alvarenga col.; A ♀, P 2♀♀; MN (ex-JCMC).
- Maxacalinius similis* Carvalho, 1976  
Rev. Brasil. Biol. 36(4):762, figs. 9–12; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa col.; A ♀, P 3♂♂; MN (ex-JCMC).
- Maxacaliscia squamosa* Carvalho & Wallerstein, 1976  
Rev. Brasil. Biol. 35(4):628, fig. 8 (1975); H ♀, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa col.; P 1; MN (ex-JCMC).
- Mecolaemus peruanus* Carvalho, 1958  
Rev. Brasil. Biol. 44(3):275, figs. 34–37 (1984); H ♂, Peru, Monson Valley, Tingo Maria, XII.11.1954, Schlinger & Ross; CAS.
- Mecolaemus tijucanus* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):465, figs. 16–19; H ♂, Corcovado, Guanabara, Brasil, 31.X.1967, Alvarenga & Seabra; A ♀; MN (ex-JCMC).
- Mecomma grandis* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(2):55, fig. 20A; H ♀, Edge of Djem-Djem Forest (c. 9,000 ft.), Abyssinia, 4.X.1926, H. Scott; BMNH.
- Mecomma luctuosa pacifica* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(2):61, fig. 20G; H ♂, Buckley, Washington, VII.1935, Oman col.; A ♀, 22♂♂♀; NMNH.
- Mecomma mimetica* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(2):57, fig. 18A; H ♀, Aspen Grove, Nicola, British Columbia, 21.VIII.1932, G. I. Spencer; P 1♀; UC.
- Mecomma orientalis himalayensis* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(1):48, fig. 18B–D; H ♂, Kurseong, E. Himalayas (5,000 ft.); BMNH.
- Mecomma orientalis orientalis* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(2):46, fig. 17A–H; H ♂, South India, T. V. Campbell; P 21♂♂; BMNH.
- Megamirioides longipilosus* Carvalho, 1985

- Rev. Brasil. Biol. 44(3):313, figs. 1–3 (1984); H ♀, Acuitlapan, Mexico, 21.XI.76; UNAM.
- Megamiris californicus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):314, figs. 4–6 (1984); H ♂, Santiago, L. Cal., VII.8.38, Michelbach & Ross col.; P 1♂; CAS.
- Megamiris longirostris* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):315, figs. 7–9 (1984); H ♂, Chinapo, Tzitzio, Michoacan, Mexico, 27.XII.37; P 1♀; UNAM.
- Megamiris nigrifascies* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):316, figs. 10–13 (1984); H ♂, 5 mi E Jacala, Hdgo., Mexico, XI.2.46, E.C. Van Dyke; P 2♀♀; NMNH.
- Megamiris saileri* Carvalho, 1953  
Rev. Brasil. Biol. 13(3):267, figs. 1, 3–4; H ♀, Nogales, Sonora, Mexico, 72.105, Car. 5.III.1952, 2.903; A ♂, P ♀; NMNH.
- Melanotrichus aureopubescens* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):81, figs. 18–22 (1973); H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N [lapsus for "S"], 52°23' W, X.1970, Fritz Plaumann; P 3♂♂; MN (ex-JCMC).
- Melanotrichus australianus* Carvalho, 1965  
Rev. Brasil. Biol. 25(3):265, figs. 1–5; H ♂, Ginninderra, Camberra, A. C. T. Acacia, 27.XI.1963, C. R. McLellan col.; A ♀, P 8♂♂, 13♀♀; ANIC.
- Melanotrichus brasiliensis* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):82, figs. 23–26; H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N [lapsus for "S"], 52°23' W, XII.1970, Fritz Plaumann; A ♀, P 5♂♂, 6♀♀; MN (ex-JCMC).
- Mexicomiris myrmecoides* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):44, figs. 10–13 (1973); H ♂, Mexico, Oaxaca, 10 mi. N. Miltepec, 15–16.VII.1971, Clark, Murray, Hart, Schaffner; A ♀, P 3♂♂, 9♀♀; NMNH.
- Mexicomiris pueblensis* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 35(2):354, figs. 16–21; H ♂, Mexico, Puebla, 6 mi sw Tehuacan, 8–10.VII.1973, Mastro & Schaffner; A ♀, P 7♂♂, 4♀♀; NMNH.
- Mexicomiris querciola* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 35(2):355, figs. 22–25; H ♂, Mexico, Nuevo Leon, 7.5 mi. S. Monterre, 21.III.1974, J. C. Schaffner; P 1♂; NMNH.
- Mexicomiris rubidus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):43, figs. 6–9 (1973); H ♂, 20 mi. NE Huajuapán de Leon, Oax., Mex., VI.28.1965, Burk, Meyer, Schaffner; A ♀, P 2♂♂, 2♀♀; NMNH.
- Microoculis nilgiriensis* Carvalho, 1982  
Rev. Brasil. Biol. 42(2):314, figs. 9–12; H ♀, Dudabetta Hill, Odacarund, Nilgiri Hills, S. India, 7800 ft, T. V. Campbell; P 2♂♂, 3♀♀; BMNH.
- Microphyllellus biobioensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):176, figs. 57–60; H ♂, Chile, Bio-Bio, 6.46, Gutierrez; P 1♂, 10♀♀; CAS.
- Millerimiris punctatus* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1–2):104, fig. 5C; H ♂, Terr. Rutshuru, 7.IV.1936 (Mission prophylactique); MRAC.

*Mimoncopeltus brevirostris* Carvalho, 1953

Rev. Brasil. Biol. 13:84, fig. 13; H ♀, Puerto Cabello (Venezuela), Sievers coll., 6.X.-1893; NMNH (ex-JCMC).

*Mimoncopeltus equadorensis* Carvalho, 1953

Rev. Brasil. Biol. 13(1):82, fig. 11; H ♀, Ecuador, Sabanilla, Ohaus leg., IX.1905; P 2♂♂; NMNH (ex-JCMC).

*Mimoncopeltus variabilis* Carvalho, 1953

Rev. Brasil. Biol. 13(1):85, figs. 14, 16; H ♂, Ecuador, Sabanilla, Ohaus S., IX.1905; A ♀, P 2♀♀; NMNH (ex-JCMC).

*Mimoncopeltus variabilis* var. *nigroclavus* Carvalho, 1953

Rev. Brasil. Biol. 13(1):85.

*Minasmiris jugatus* Carvalho, 1980

Lundiana 1:130, figs. 1–6; H ♂, Minas Gerais, Brasil, Carmo do Rio Claro, 1947, Carvalho; P 1♂; MN (ex-JCMC).

*Minytus cuiabanus* Carvalho, 1976

Rev. Brasil. Biol. 35(4):686, figs. 12–20 (1975); H ♂, Paramaribo, Suriname, V.1955, J. C. M. C. Carvalho col.; A ♀, P 3♂♂; NMNH (ex-JCMC).

*Minytus guaranianus* Carvalho, 1976

Rev. Brasil. Biol. 35(4):688, figs. 21–28 (1975); H ♂, Nova Teutônia, Santa Catarina, Brasil, 2.I.1935, Fritz Plaumann col.; MN (ex-JCMC).

*Minytus portoricensis* Carvalho & Maldonado, 1982

Rev. Brasil. Biol. 42(3):561, figs. 5–11; H ♂, Puerto Rico, Guavate, VIII.1969, R. Bonilla; NMNH.

*Miomonalion conoidifrons* Sailer & Carvalho, 1957

U.S. Geol. Surv. Prof. Paper 294-G:258, figs. 8–9; H sex undetermined, Calico Mountains, Mojave Desert, southeastern California, USGS Cenozoic locality 19057; NMNH.

*Mixtecimiris setosus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):26, figs. 6–10 (1973); H ♂, Mexico, Puebla, 1.6 mi SW Zapotitlan, July 16, 1971, Clark, Hart, Murray, Schaffner; A ♀, P 8♂♂, 6♀♀; NMNH.

*Monalocoris carioca* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(1):101, figs. 4–7; H ♂, Corcovado, Rio de Janeiro, 2.II.1947, Wygod. leg.; A ♀, P 3♂♂, 4♀♀; MN (ex-JCMC).

*Monalocoris neotropicalis* Carvalho & Gomes, 1969

Rev. Brasil. Biol. 29(2):228, fig. 6; H ♀, Troya, 2900m., VI.1965, L. F. Peña col.; P 4♀♀; NMNH (ex-JCMC).

*Monalocoris nigrus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:76, figs. 158–161; H ♂, New Guinea, NE, Karimui, south of Goroka, 1000 m, 3.VI.1961, J. L. Gressitt; P 6♂♂, 15♀♀; BPBM.

*Monalocoris pallipes* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:77, figs. 162–165; H ♂, New Guinea, NE Cental District, Guar'l, 1900–2100 m, X.1968, N.L.H. Krauss; P 9♂♂, 18♀♀; BPBM.

*Monalonion aimaranus* Carvalho, 1972

An. Acad. Brasil. Ci. 44(1):122, figs. 1–4; H ♂, Locotal Chapare, Bolivia, 1200m, XI.1953, Prosen col.; A ♀, P 12♂♂♀♀; NMNH (ex-JCMC).

*Monalonion columbiensis* Carvalho, 1984



Rev. Gallesc. 1(4):18, figs. 18–21; H ♀, Colombia, Porce (Ant.), en guano (*Inga* sp.), Dic., 1982, R. Velez; P 1♂, 6♀♀; MEFLG.

*Monalonion incaicus* Carvalho, 1972

An. Acad. Brasil. Ci. 44(1):136, figs. 27–30; H ♀, Peru, Callanga; A ♂; NMNH (ex-JCMC).

*Monalonion itabunensis* Carvalho, 1972

An. Acad. Brasil. Ci. 44(1):137, figs. 31–34; H ♀, CEPEC, quadra-E, Itabuna, Bahia, 11.VI.1968; A ♂, P 7♂♂♀; MN (ex-JCMC).

*Muirmiris borneensis* Carvalho, 1983

Rev. Brasil. Biol. 43(2):147, fig. 1; H ♀, Mowong, W. Borneo, F. Muir, Sept. 1907; BMNH.

*Mycetocyclus pacificus* Carvalho, 1956

Ins. Micronesia 7(1):16, figs. 9, 46c–e; H ♀, Koror I., Palau Is., at light, 25.IV.1953, J. W. Beardsley; A ♂, P 2♀♀; NMNH.

*Myombea bathycephala* China & Carvalho, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:1121, figs. 1, 2D–E; H ♂, Tanganyika Territory, Myombe River, 15.III.1914 (Lieut. J. Hansi); A ♀, P 1♂; BMNH.

*Myrmecoroides grossi* Carvalho, 1973

Rev. Brasil. Biol. 33(4):7, figs. 16–20; H ♂, Otford, New South Wales, 1.XII.1962, D. K. McAlpine; A ♀, P ♂, ♀; AM.

*Nabirecoris minutus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:78, fig. 166; H ♀, New Guinea, NW Nabire, S. Geelvink Bay, 0–30 m, 2–9.VII.62, J. L. Gressitt & J. Sedlacek; BPBM.

*Nanniresthenia minuscula* Carvalho & Fontes, 1970

Rev. Brasil. Biol. 30(4):522, figs. 3, 8–10; H ♂, Fiebrig, Paraguay, Chaco; A ♀, P 3♂♂, 2♀♀; NMNH (ex-JCMC).

*Nanniresthenia peruana* Carvalho, 1961

Rev. Brasil. Biol. 21(4):462, figs. 1–4; H ♀, 60 mi. N of Puno, Peru, 28.II.1951, Ross & Michelbacher col.; A ♂, P 1♂, 1♀; CAS.

*Nanniresthenia proluteiceps* Carvalho & Fontes, 1970

Rev. Brasil. Biol. 30(4):519, figs. 1, 4–6; H ♂, Cordoba, Argentina, Dep. de Calamuchita, El Sauce, XII.1938, Manoel J. Viana; A ♀, P 9♀♀, 5♂♂; MLP (ex-JCMC).

*Nannomiris hondurensis* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):497, fig. 1; H ♂, Tegucigalpa, Honduras, F. J. Dyer col.; NMNH (ex-JCMC).

[*Neela caipora*—see *Neella caipora*]

*Neella anduzei* Carvalho, 1954

Bol. Mus. Nac., Zool. 122:1, figs. 1, 14, 17–19, 22–23; H ♂, Sabana Grande, Trujillo, Venezuela, P. Anduzee col., A ♀, P 11♂♂♀♀; NMNH (ex-JCMC).

*Neella caipora* Carvalho, 1948

An. Acad. Brasil. Ci. 20(1):103, figs. 14–17 (as “*Neella caipora*”); H ♂, Mata do Caipora, Fazenda da Alegria, Carmo do Rio Claro, Minas Gerais, XI.1947, Carvalho col.; P 1♂; MN (ex-JCMC).

*Neella carmelitana* Carvalho, 1945

Rev. Ent. R. J. 16(1–2):168, figs. 3, 18–20; H ♂, Fazenda da Algeria, Carmo do

Rio Claro, Minas Gerais, XII.1943, Carvalho col.; A ♀, P 5♂♂, 1♀; MN (ex-JCMC).

*Neella cinnamomea* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):466, figs. 20–23; H ♂, Horto Florestal, Belo Horizonte, MG, C. S. Acasio col.; A ♀, P 3♂♂, 10♀♀; MN (ex-JCMC).

*Neella cuneata* Carvalho, 1954

Bol. Mus. Nac. Ci. 122:2, fig. 2; H ♀, Bolivia, Santa Cruz., II.1950, A. Martinez col.; NMNH (ex-JCMC).

*Neella decarloi* Carvalho, 1954

Bol. Mus. Nac., Zool. 122:3, fig. 3; H ♂, Misiones, Republica Argentina, P. Prosen col.; MLP (ex-JCMC).

*Neella distincta* Carvalho, 1945

Rev. Ent. R. J. 16(1–2):170, figs. 4, 21–23; H ♂, Teresópolis, Est. do Rio, 1.IX.1940 (Trav. & Freitas col.); IOC.

*Neella ecuatoriana* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):254, figs. 11–15; H ♂, Rio Macuma, Equador, VII.1971, Borys Malkin; P 1♂; NMNH (ex-JCMC).

*Neella explanata* Carvalho, 1954

Bol. Mus. Nac., Zool. 122:4, figs. 6, 30–33; H ♂, Peru, Callanga; A ♀, P 3♂♂, 3♀♀; NMNH (ex-JCMC).

*Neella itacoaiensis* Carvalho, 1954

Bol. Mus. Nac., Zool. 122:5, figs. 4, 13, 15, 27, 29; H ♂, Rio Itacoai, Amazonas, Brasil, J. C. M. Carvalho col., VI.1950; P 11♂♂♀♀; MN (ex-JCMC).

*Neella mantiqueirae* Carvalho, 1954

Bol. Mus. Nac., Zool. 122:7, figs. 5, 20, 21, 24, 26, 33; H ♂, Maromba, Itatiaia (*Epidendron*), 25.XI.1942, Zikan leg.; P 3♂♂, 2 nymphs; MN (ex-JCMC).

*Neella nigrnotata* Carvalho, 1954

Bol. Mus. Nac., Zool. 122:7, figs. 5, 7, 10–11; H ♂, Peru, Iguapo, A ♀, P 3♀♀, 1♂; NMNH (ex-JCMC).

*Neella peruana* Carvalho, 1975

An. Acad. Brasil. Ci. 46(2):324, figs. 2–5 (1974); H ♂, Peru, Monson Valley, Tingo Maria, 2.X.1934, E. I. Schlinger & E. S. Ross col.; P 1♂; CAS.

*Neella similaris* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):467, figs. 24–27; H ♂, Campo Belo, Itatiaia, 12.X.1957, em arácea, J. Machado & Myriam Chapot colls.; A ♀, P 7♂♂, 10♀♀; MN (ex-JCMC).

*Neoborella brevirostris* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):52, figs. 9–12 (1973); H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N [lapsus for "S"] 52°23' W, X.1970, Fritz Plaumann; A ♀, P 3♂♂; MN (ex-JCMC).

*Neocaulotops brevirostris* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(1):66, fig. 1; H ♀, Mendoza, Laguna de Diamante, 2000m, 27.I.1950, M. A. Czel; MLP (ex-JCMC).

*Neofurius bifasciatus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):276, figs. 38–41 (1984); H ♂, 45 km sw Cintalpa, Chiapas, Mexico, Aug. 12.1967, el 2,500', H.R. Burke & J. Hafernack; NMNH.

*Neofurius bimaculatus* Carvalho & Hsiao, 1954

Rev. Brasil. Ent. 1:140, figs. 1, 6H-I, 7A; H ♂, Limon Plantation, Chagres River, R. Panamá, 14.VIII.1918, sweeping around cornfield, H. F. Sietz & J. Zetek col., cat. no. 61998; A ♀, P♂♀, varios; NMNH.

*Neofurius capichabensis* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):206, figs. 2-6; H ♂, Vila do Alegre X, Espirito Santo, Brasil, A. Heyne, Berlin-wilm; A ♀, P 2♂♂; MN (ex-JCMC).

*Neofurius columbiensis* Carvalho, 1984

Rev. Galleosc. 1(4):19, figs. 22-25; H ♂, Colombia, Cundinamarca, La Salina, 1,800 m, Abr., 1965, J. A. Ramos; MEFLG.

*Neofurius discovittatus* Carvalho & Hsiao, 1954

Rev. Brasil. Ent. 1:143, fig. 3; H ♀, El Topo, Ecuador, 5.X.1944, E. J. Hambleton col., Cat. no. 61986; P 3♂♂; NMNH.

*Neofurius elegantulus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):13, figs. 6-9 (1973); H ♂, Costa Rica, San Jose, 8.3 mi. N San Isidro del General, 30.VI.1972, R. R. & M. E. Murray; A ♀, P 1♂, 4♀♀; NMNH.

*Neofurius itatiaianus* Carvalho & Fontes, 1967

Rev. Brasil. Biol. 27(3):315, figs. 1-4; H ♂, Parque Nacional do Itatiaia, Brasil, VII.1960, Aristoteles Silva col.; A ♀, P 9♂♂, 16♀♀; MN (ex-JCMC).

*Neofurius montei* Carvalho & Hsiao, 1954

Rev. Brasil. Ent. 1:146, fig. 5; H ♀, S. Paulo, Capital, O. Monte col. 1943; P 4♀♀; MN (ex-JCMC).

*Neofurius nigroscutellatus* Carvalho & Hsiao, 1954

Rev. Brasil. Ent. 1:142, figs. 2, 6E-G, 7B; H ♂, Guadeloupe, W. I., alt. 3000 ft., 30.VII (A. Busck) Cat. no. 61985; A ♀, P 7♂♂, 8♀♀; NMNH.

*Neofurius nigrotibialis* Carvalho & Hsiao, 1954

Rev. Brasil. Ent. 1:144, figs. 6B-D, 7C; H ♂, Dominica Is., W. I., 15.VI.1941, R. G. Fennah col., Cat. no. 61987; P 1♂; NMNH.

*Neofurius pallidus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):276, fig. 42 (1984); H ♀, Citrico, Delega, Chiriqui, Panamá, 10.III.74, Dodge Engleman; P 2♀♀; NMNH.

*Neofurius paraguayensis* Carvalho & Drake, 1943

Rev. Ent. R. J. 14(3):522; H ♀, Horqueta, Paraguay; P ♀; DC in NMNH.

*Neofurius parauara* Carvalho, 1981

Rev. Brasil. Biol. 41(1):14, figs. 7-12; H ♂, Belém, Pará, Mocambo, Brasil, M. F. Torres; MN (ex-JCMC).

*Neofurius urucuianus* Carvalho & Hsiao, 1954

Rev. Brasil. Ent. 1:145, figs. 4, 7D; H ♂, Taboca, Rio Paru de Leste, Para, Brasil, J. C. M. Carvalho col., VII.1951; A ♀, P 3♂♂, 5♀♀; MN (ex-JCMC).

*Neofurius viridis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):277, fig. 43 (1984); H ♀, Hidalgo State, Mexico, 136 km, I.11.8, J. Calwell '46; UNAM.

*Neoleucon rubrotylus* Carvalho, 1954

Jour. Kans. Ent. Soc. 27(3):102, fig. 2A; H ♀, Fortin, V. C., Mexico, intercepted

at Laredo, Texas, 7.X.1952, on *Philodendron* plants, cat. no. 61989; A ♂, P 1♀, 1♂; NMNH.

*Neoneella argentina* Carvalho, 1960

Arq. Mus. Nac. R. J. 50:48, figs. 1, 10, 19–21; H ♂, Buenos Aires, Republic Argentina, 1946, Carvalho col.; A ♀, P 1♀, 11♂♂; MLP (ex-JCMC).

*Neoneella bosqui* Carvalho, 1946

Bol. Mus. Nac., Zool. 61:1, figs. 1–4, 16; H ♂, Misiones, Eldorado (alto Parana), 12.1945, Juan M. Bosq col.; A 1♀, P 43♂♂, 11♀♀; MLP (ex-JCMC).

*Neoneella milzae* Carvalho, 1946

Bol. Mus. Nac., Zool. 54:2, figs. 5–8; H ♂, Itatiaya (Wygodzinsky leg.); A 1♀, P 4♀♀; MN (ex-JCMC).

*Neoneella paranaensis* Carvalho, 1946

Bol. Mus. Nac., Zool. 54:2, figs. 9–11; H ♂, Guarapuava, Paraná (O. Monte leg.); MN (ex-JCMC).

*Neotropicomiris costalis* Carvalho & Fontes, 1969

Rev. Brasil. Biol. 29(3):334, figs. 5–8; H ♂, Paraná, Brasil, Staviarski leg., 4.1952, JCMC; A ♀, P 3♀♀, 2♂♂; MN (ex-JCMC).

*Neotropicomiris ecuadorensis* Carvalho & Fontes, 1969

Rev. Brasil. Biol. 29(3):336, figs. 9–12; H ♂, S. Cuenca, 2500–2800m, III.1968, Ecuador, L. F. Peña col.; A ♀, P 12♀♀, 10♂♂; NMNH (ex-JCMC).

*Neotropicomiris longirostris* Carvalho & Fontes, 1969

Rev. Brasil. Biol. 29(3):337, figs. 13–16; H ♀, Minas Gerais, Carmo do Rio Claro, IX.1947, J. C. M. Carvalho col.; A ♂, P 2♀♀, 1♂; MN (ex-JCMC).

*Neotropicomiris nordicus* Carvalho & Fontes, 1969

Rev. Brasil. Biol. 29(3):338, figs. 17–20; H ♂, San Diego, Merida, VIII.1943, Venezuela, P. Anduze col.; A ♀, P 2♂♂, 1♀; NMNH (ex-JCMC).

*Neotropicomiris pilosus* Carvalho & Fontes, 1969

Rev. Brasil. Biol. 29(3):340, figs. 21–24; H ♂, Rio d'Ouro, RJ, Brasil, 1946, Carvalho col.; A ♀, P 1♂; MN (ex-JCMC).

*Nicrostratus luteus* China & Carvalho, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:1124; H ♀, Siamese Malay States, Biserat; BMNH.

*Nicostratus minor* China and Carvalho, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:1122, fig. 2A–C; H ♂, Kuching, Borneo, IV.1906 (J. Hewitt coll.); A ♀, P 1♀; BMNH.

*Nigrimiris pallidipes* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):21, figs. 8–11 (1973); H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N, 52°23' W, September, 1970, Fritz Plaumann; A ♀, 5♂♂, 5♀♀; MN (ex-JCMC).

*Notholopus carmelitanus* Carvalho & Ferreira, 1971

Rev. Brasil. Biol. 31(2):167, figs. 2–5, H ♂, Minas Gerais, Brasil, Carmo do Rio Claro, 1947, col. Carvalho; A ♀, P 8♂♂, 5♀♀; MN (ex-JCMC).

*Notholopus colombianus* Carvalho, 1975

Rev. Brasil. Biol. 35(3):370, figs. 1–3, H ♂, Buenaventura, Colombia, 10.V.1951, E. R. Ross col.; NMNH (ex-JCMC).

*Notholopus coreoides* Carvalho, 1975



- Rev. Brasil. Biol. 35(3):371, figs. 4–8; H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; A ♀, P 21♂♂♀; MN (ex-JCMC).
- Notholopus cuiabanus* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):373, figs. 9–13; H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; A ♀, P 60♂♂♀; MN (ex-JCMC).
- Notholopus sertanejus* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):376, figs. 18–23; H ♂, Sinop, Rio Teles Pires, Mato Grosso, IX.1974, Alvarenga & Roppa col.; A ♀, P 20♂♂♀; MN (ex-JCMC).
- Oaxacaenus vitreus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):72, figs. 13–16 (1973); H ♀, Mexico, Oaxaca, 2.7 mi. nw. El Camaron, 13.VII.1971, taken at light, Clark, Murray, Hart, Schaffner; P 1♂; NMNH.
- Ofellus costaricensis* Carvalho & Sailer, 1953  
Proc. Ent. Soc. Wash. 55(5):235, figs. 2, 8–10; H ♂, San Jose, Costa Rica, 6.V.1946, Bierig coll.; P 1♀; NMNH (ex-JCMC).
- Ofellus guaranianus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):318, figs. 14–17 (1984); H ♀, Porto Alegre, R.S. Brasil. 4.1963, ex Orthezia; P 5♂♂, 5♀♀; MN.
- Ofellus mantiqueiranus* Carvalho & Sailer, 1953  
Proc. Ent. Soc. Wash. 55(5):236, figs. 3, 5–7; H ♂, Campos do Jordão, Estado de São Paulo, Brazil, 1600 mi, Wygodzinsky leg.; MN (ex-JCMC).
- Ofellus mexicanus* Carvalho & Sailer, 1953  
Proc. Ent. Soc. Wash. 55(5):235, figs. 1, 11–12; H ♀, Cuernavaca, Morales, Mexico, 9.VIII.1944, N. L. H. Krauss, U. S. N. M. no. 61649; A ♂, P 5♀♀; NMNH.
- Orthotylus bahianus* Carvalho, 1976  
Rev. Brasil. Biol. 36(4):766, figs. 5–9; H ♂, Encruzilhada, Bahia, Brasil, Seabra & Roppa col.; A ♀, P 8♂♂, 7♀♀; MN (ex-JCMC).
- Orthotylus chilensis* Carvalho & Fontes, 1973  
Rev. Brasil. Biol. 33(4):495, fig. 1; H ♀, Santiago, Chile, XI-52, Kushel col.; P 2♀♀; NMNH (ex-JCMC).
- Orthotylus diamantinus* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):103, figs. 15–18; H ♂, Diamantino, Faz. S. João, Mato Grosso, Brasil, Km 20, Br 16, Roppa col.; P ♂, ♀; MN (ex-JCMC).
- Orthotylus guaranianus* Carvalho & Fontes, 1973  
Rev. Brasil. Biol. 33(4):496, figs. 2–5; H ♂, Paraguai, Horqueta, 1938, Alberto Schulze; A ♀, P 4♂♂; NMNH (ex-JCMC).
- Orthotylus manauensis* Carvalho, 1983  
Acta Amazon. 13(1):177, figs. 1–6; H ♂, Brasil, AM (Amazonas), Praia das Laranjeiras (Manaus), 4.IV.81, Arias col.; P 10♂♂, 11♀♀; INPA.
- Orthotylus nigrescens* Carvalho & Fontes, 1973  
Rev. Brasil. Biol. 33(4):497, figs. 6–9; H ♂, Eltofo, Coquimbo, Chile, X.1952; A ♀, P 21♂♂, 12♀♀, 4 ninfas; NMNH (ex-JCMC).
- Orthotylus platensis* Carvalho & Fontes, 1973  
Rev. Brasil. Biol. 33(4):498, figs. 10–13; H ♂, R. Uruguai, Montivideu, 1943, Carvalho; P 3♂♂; NMNH (ex-JCMC).

*Orthotylus sulinus* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(3):525, figs. 10–13; H ♂, Republica Argentina, San Jeronimo, San Luis, 1974; A ♀, P 1♀; MACN.

*Pachymerocerus brasiliensis* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(1):102, fig. 8; H ♂, S. Bocaina, 1650m, S. J. Barreiro, SP, Brasil, 1.1969, M. Alvarenga col.; MN (ex-JCMC).

*Pachymerocerus carioca* Carvalho, 1985

Rev. Brasil. Biol. 44(3):277, fig. 44 (1984); H ♀, Represa R. Grande, Rio de Janeiro, Brasil, II.76, M. Alvarenga; MN.

*Pachymerocerus pilosus* Carvalho, 1947

An. Acad. Brasil. Ci. 19(1):108, figs. 4–7; H ♂, Viçosa, M. Gerais, 1945, Carvalho col.; A ♀, P 3♂♂; MN (ex-JCMC).

*Pachymerocerus platensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):278, figs. 45–50 (1984); H ♀, I. Martin Garcia, Argentina, 20.IV.1925, col. Prosen; P 5♂♂, 5♀♀; MLP.

*Pachypeltis gigas* Carvalho, 1981

Rev. Brasil. Biol. 41(3):483, fig. 12; H ♀, Tundong, pepper, Sarawak (N. Borneo), 17.III.64, JK; BMNH.

*Pachypoda guatemalensis* Carvalho & China, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:690, fig. 7A–B; H ♂, San Isidro, Champion coll.; P 1♂; BMNH.

*Pachypoda major* Carvalho, 1985

Rev. Brasil. Biol. 44(3):279, fig. 51 (1984); H ♀, Costa Rica, Punta Arenas, Monteverde area, 6–14, June, 1973, 1400–1700 m, Erwin & Hevel Central America Expedition 1973; NMNH.

*Pachypoda sordida* Carvalho & China, 1951

Ann. Mag. Nat. Hist., Ser. 12 4:691, fig. 7C–D; H ♀, La Palma, 1600m, 1905, P. Brolley, Distant coll., B. M. 1911.383; A ♂, P 1♀; BMNH.

*Pachypoda turrialba* Carvalho, 1985

Rev. Brasil. Biol. 44(3):280, figs. 52–55 (1984); H ♂, Turrialba, Costa Rica, 5 June 1951, O.L. Cartwright; P 2♂♂, 3♀♀; NMNH.

*Palaeofurius cyclopensis* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:79, figs. 167–170; H ♂, New Guinea, Neth., Cyclops Mts., Ifar, 300 m, II.21.1959, T. C. Maa; P 2♂♂, 7♀♀; BPBM.

*Palaeofurius nigroemboliatus* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:80, figs. 171–174; H ♂, New Guinea, Neth., Warris S of Hollandia, 450–500 m, VIII.24–31.59, T. C. Maa; P 1♂, 1♀; BPBM.

*Palaucoris biroi* Carvalho, 1984

Rev. Brasil. Biol. 44(1):82, figs. 1–7; H ♂, New Guinea, Biro, 1896, Seleio, Berlinhafen; NMNH (ex-JCMC).

*Palaucoris (T.) clypeatus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):84, figs. 12–13; H ♀, New Guinea, Biro, 1896, Seleio and Tamara, Berlinhafen; P 2♀♀; NMNH (ex-JCMC).

*Palaucoris unguidentalis* Carvalho, 1956

Ins. Micronesia 7(1):49, figs. 7, 28, 53e–f; H ♂, Ulimang, Babelthuap, Palau Is., 22.XII.1947, H. S. Dybas; A ♀, P 6♀♀; NMNH.

*Panamacoris stramineus* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):470, fig. 32; H ♀, Paraiso, CZ, Pan., I-28-11, August Busck; P 1♀; NMNH (ex-JCMC).

*Parabryocoropsis cheesmanae* China & Carvalho, 1951

Bull. Ent. Res. 42(2):468, fig. 4b, e; H ♂, Papua, Kokoda, 1200 feet, IV.1963 (L. E. Cheesman); A ♀; BMNH.

*Parabryocoropsis duni* China & Carvalho, 1951

Bull. Ent. Res. 42(2):471; H ♀, Kabeira Plantation near Lowland Experiment Station, Keravat, New Britain, III.1950 (G. S. Dun); P 4♀♀; BMNH.

*Parabryocoropsis typicus* China & Carvalho, 1951

Bull. Ent. Res. 42(2):468, figs. 3-4A, D; H ♂, Kabeira Plantation near Lowlands Experiment Station, Keravat, New Britain, III.1950 (G. S. Dun); A ♀, P 10♂♂, 2♀♀; BMNH.

*Paracarnus guadalupensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):374, fig. 37 (1984); H ♀, Trois Rivières, Guadeloupe, Dufau; P 1♀; NMNH.

*Paracarnus haitianus* Carvalho, 1952

An. Acad. Brasil. Ci. 24(2):182, fig. 2; H ♀, Cap. Haiten, Haiti, C. Gagzo leg, 1905 ded., 6.V.1905; P 1♀; BMNH.

*Parachius rufovittatus* Carvalho, 1944

Rev. Ent. R. J. 15(102):163, fig. 1; H ♀, Angra dos Reis, Japuiba, Estado do Rio de Janeiro, Brasil, 2-I-944, Wygodzinsky leg.; IEA.

*Parachius virescens* Carvalho & Gomes, 1968

An. Acad. Brasil. Ci. 40(4):536, fig. 18; H ♀, Tandapi, 1300/1500m, VI.1965, L. F. Peña col., Equador; NMNH (ex-JCMC).

*Paracylapus insularis* Carvalho, 1952

Mem. Inst. Sci. Madagascar, Ser. E 1(1):97, fig. 3; H ♀, Montagne d'Ambre, (XII.48, R. Paulian) Madagascar; MHNP.

*Paradacerla azteca* Carvalho & Usinger, 1957

Wasmann Jour. Biol. 15(1):10, fig. 2; H ♂, Mexico Valley, Koebele, 1907; A ♀; CAS.

*Parafulvius amazonicus* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):251, fig. 1; H ♀, Sinop, 12°31' S, 55°37' W, Br 16 Km 500a 600, Mato Grosso, Brasil, 350m, IX.1974, Alvarenga & Roppa; P 1♀; MN (ex-JCMC).

*Parafulvius amblytyloides* Carvalho, 1954

Proc. Iowa Acad. Sci. 61:505, figs. 1-4; H ♀, Rio de Janeiro, Brasil, J. C. M. Carvalho col., 1948; A ♂, P 8♀♀, 4♂♂; MN (ex-JCMC).

*Parafulvius fasciatus* Carvalho & Maldonado, 1973

Rev. Brasil. Biol. 33(1):39, figs. 1-4; H ♂, Colombia, Villavicencio, Meta, 18.IX.1965, J. A. Ramos coll.; A ♀, P 8♂♂♀♀; NMNH (ex-JCMC).

*Parafurius diminutus* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):470, figs. 33-36; H ♂, Pará, Brasil, Rio Paru, VII.1952, JCMC col.; A ♀, P 9♂♂, 15♀♀; MN (ex-JCMC).

*Parafurius unicolor* Carvalho & Gomes, 1968

An. Acad. Brasil. Ci. 40(4):533, figs. 7-9; H ♂, San Domingo (de los Colorados), IX.1962, JCMC col., Equador; A ♀, P 12♂♂♀♀; NMNH (ex-JCMC).

*Pararagmus ceylonensis* Carvalho, 1955

Rev. Chil. Ent. 4:225, n.n. for *Pararagmus annulicornis* Poppius, 1911, Ofv. Finska Vet.-Soc. Forh. 53A(2):35, preoc. by *Pararagmus annulicornis* (Reuter, 1879), Acta Soc. Sci. Fenn. 13:298.

*Paramyiomma hemialba* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):384; H ♀, S. Africa, R. E. Turner, 1921-210, Mossel Bay, Cape Province, IV.1921; BMNH.

*Paramyiomma lansburyi* Carvalho, 1951

An. Acad. Brasil. Ci. 23(4):384, fig. 2a; H ♂, S. India, Kodai Kanal, Pulney Hills, 7000 feet, Dr. T. V. Campbell, B. M. 1928-189; P 2 specimens; BMNH.

*Paramyiomma surinamensis* Carvalho & Rosas, 1962

Rev. Brasil. Biol. 22(4):419, figs. 1-5; H ♂, collected on light trap at the Beryln Estate (cacao) on the north bank of the river Commewijne, Suriname (no. 1119), P. H. van Doesburg Jr., 29. VIII.1961; P 50♂♂; NMNH (ex-JCMC).

*Paraneella amazonica* Carvalho, 1954

Jour. Kans. Ent. Soc. 27(3):101, fig. 1; H ♀, Rio Itacoai, Estado do Amazonas, Brasil, VII.1950, J. C. M. Carvalho; MN (ex-JCMC).

*Paraproba amazonica* Carvalho, 1983

Acta Amazon. 13(1):178, figs. 7-10; H ♂, Brasil, Amazonas, P. das Laranjeiras (Manaus), 4.IX.81, Jorge Arias col.; P 2♂♂; INPA.

*Paraproba peruana* Carvalho & Ferreira, 1972

Rev. Brasil. Biol. 32(2):181, figs. 9-13; H ♂, Lima, 20.V.1964, Ravel col.; P 2♂♂; NMNH (ex-JCMC).

*Paraproba singularis* Carvalho & Gomes, 1969

Rev. Brasil. Biol. 29(2):228, fig. 7; H ♀, Loja, III.1965, L. F. Peña col.; P 1♂, 2♀♀; NMNH (ex-JCMC).

*Paraxenetus alvarengai* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):161, figs. 1-3 (1973); H ♂, Chapada dos Guimarães, Mato Grosso, XI.1963, M. Alvarenga col.; MN (ex-JCMC).

*Paraxenetus aspersus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):163, figs. 8-10 (1973); H ♂, Juazeirinho, Soledade, Paraíba, Brasil, 20.III.1965, A. G. A. Silva col.; A ♀, P 4♂♂; MN (ex-JCMC).

*Paraxenetus bahianus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):164, figs. 11-14 (1973); H ♂, Encruzilhada, Bahia, Brasil, XI.1971, 960m, Seabra & Roppa col.; A ♀, P 7♂♂♀♀; MN (ex-JCMC).

*Paraxenetus brasiliensis* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):167, figs. 20-22 (1973); H ♂, Brasília, Goiás, 15.V.1967, 900m, D. Albuquerque col.; A ♀, P 2♂♂, 1♀; MN (ex-JCMC).

*Paraxenetus cuiabanus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):168, figs. 24-26 (1973); H ♂, Com. Inst. O. Cruz, Salobra, Brasil, Mato Grosso, 3.1940; MN (ex-JCMC).

*Paraxenetus minusculus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):170, figs. 32-35 (1973); H ♂, Km. 47, Estrada Rio-S. Paulo, 2.1946, Wygodzinsky leg.; A ♀, P 2♂♂, 1♀; MN (ex-JCMC).

*Paraxenetus paranaensis* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):172, figs. 36-39 (1973); H ♂, Paraná, Brasil, Carvalho col.; A ♀; MN (ex-JCMC).



*Paraxenetus pirapora* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(1):191, figs. 1-4; H ♂, Pirapora, Minas Gerais, Brasil, XI.1976, Seabra, Monne & Roppa col.; A ♀, P 25♂♂, 1♀; MN (ex-JCMC).

*Paraxenetus seabrai* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):173, figs. 40-44 (1973); H ♂, Encruzilhada, Bahia, XI.1972, 960 m, Seabra & Roppa cols.; A ♀, P 1♀; MN (ex-JCMC).

*Paraxenetus trifasciatus* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(1):192, figs. 5-8; H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, 12°31' S, 55°37' W, BR 163 Km, 500 a 600, 350m, X.1974, Alvarenga & Roppa col.; MN (ex-JCMC).

*Pauliana antennatus* Carvalho, 1952

Mem. Inst. Sci. Madagascar, Ser. E 1(1):95, figs. 1, 2A-C; H ♂, Ambodivoangy, Maroantsetra, Madagascar; MHNH.

*Peltidocylapus carmelitanus* Carvalho & Fontes, 1968

Rev. Brasil. Biol. 28(3):276, figs. 1-4; H ♂, Carmo do Rio Claro, MG, I.1958, Carvalho & Becker col.; A ♀, P 1♀; MN (ex-JCMC).

*Penacaros longicuneatus* Carvalho & Rosas, 1966

Rev. Brasil. Biol. 26(1):75, figs. 1-4; H ♂, Caramavida, Nahuelbuta (W) (Arauco), 720, 1000m, 5-10.II.1953, col. L. E. Peña; P 1♂; CIE.

*Perissobasis bahiensis* Carvalho, 1982

Rev. Brasil. Biol. 42(2):336, figs. 1-6; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m. Encruzilhada, Bahia, Brasil, XI, 1972, Seabra & Roppa; P 12♂♂, 14♀♀; MN (ex-JCMC).

*Perissobasis columbiensis* Carvalho, 1982

Rev. Brasil. Biol. 42(2):338, figs. 7-9; H ♀, Colombia, Cundinamarca, Finca Bella, vista nr Sasaina, 19.IV.65, P. R. Craig; NMNH (ex-JCMC).

*Perissobasis matogrossensis* Carvalho, 1982

Rev. Brasil. Biol. 42(2):339, figs. 10-17; H ♂, Sinop, Tio Teles Pires, Mato Grosso, Brasil, X.75, Alvarenga & Roppa; P 2♀♀; MN (ex-JCMC).

*Peritropella malgache* Carvalho, 1981

Rev. Brasil. Biol. 41(3):463, fig. 2; H ♀, Ambodivoangy, J. Vadon; NMNH (ex-JCMC).

*Peritropis gressitti* Carvalho, 1976

Ins. Micronesia 7(1):9, fig. 6c-d; H ♂, (US), Koror I., Palau Is., Limestone Ridge south of inlet, 21.I.1948, H. S. Dybas; A ♀, P 17♂♂; NMNH.

*Peritropis guamensis* Carvalho, 1956

Ins. Micronesia 7(1):10, figs. 4, 5b, 6h-i, 8c; H ♂, (US), Pt. Oca, Guan., light trap, 27.V.1945, G. E. Bohart & J. L. Gressitt; A ♀, P 23♂♂; NMNH.

*Peritropis ponapensis* Carvalho, 1956

Ins. Micronesia 7(1):12, figs. 5a, 6a-b, 8a; H ♂, (US), Mt. Kupwuris, Ponape, North slope at 1000 to 1500 ft. alt., 11.III.1948, H. S. Dybas; P 4♂♂; NMNH.

*Peritropis punctatus* Carvalho & Lorenzato, 1978

Rev. Brasil. Biol. 38(1):144, figs. 74-77; H ♂, New Guinea, Neth., Boden, 100m, 11 Km SE of Oerberfaren, 7-17.VII.1959, T. C. Maa col.; A ♀, P 8♂♂, 2♀♀; BPBM.

*Peritropis unicolor* Carvalho & Rosas, 1965

An. Acad. Brasil. Ci. 37(1):83, figs. 1-2; H ♀, Fiebrig, Paraguay, San Bernardino; NMNH (ex-JCMC).

*Peritropis yapensis* Carvalho, 1956

Ins. Micronesia 7(1):13, figs. 3g, 6, 8d; H ♂, (US), Hill behind Yaptown, Yap I., 28.XI.1952, J. L. Gressitt; NMNH.

*Peritropisca bituberculata* Carvalho & Lorenzato, 1978

Rev. Brasil. Biol. 38(1):146, figs. 78–82; H ♂, New Guinea, NE Wau, 1750m, 18.V.1959, J. Sedlacek; BPBM.

*Peritropoides annulata* Carvalho, 1955

Proc. U.S. Nat. Mus. 103(3337):625, plate 15B; H ♀, USNM 61940, Colombia (on orchid), intercepted at San Francisco, Calif., 16.XII.1940; NMNH.

*Peritropoides ariasi* Carvalho, 1982

Acta Amazon. 12(2):409, fig. 1; H ♂, Reserva Ducke, Manaus, Amazonas, Brasil, 9.VIII.1977, Jorge Arias; P 1♀; INPA.

*Peritropoides barensis* Carvalho, 1982

Acta Amazon. 12(2):410, fig. 2; H ♀, Brasil, Amazonas, P. das Laranjeiras, 8–14.IX.81, Jorge Arias; INPA.

*Peritropoides duckei* Carvalho, 1982

Acta Amazon. 12(2):411, fig. 3; H ♂, Brasil, Amazonas, Reserva Ducke, AM-10 Km 26, 16.VIII.1977, Jorge Arias; INPA.

*Peritropoides pennyi* Carvalho, 1982

Acta Amazon. 12(2):412, figs. 4–7; H ♂, Brasil, Amazonas, P. das Laranjeiras, 4.IX.81, Jorge Arias; INPA.

*Peritropoides quadrinotatus* Carvalho, 1955

Proc. U.S. Nat. Mus. 103(3337):625, figs. 74b, 75e–f, 76b, f; H ♂, USNM 61941, Barro Colorado Island, Canal Zone, Panama, VII.1923, R. C. Shannon; NMNH.

*Peruanocoris pilosus* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):252, figs. 2–6; H ♂, Sinop, 21°31' S, 55°37' W, Br 163 Km 500 a 600, Mato Grosso, Brasil, 350m, IX.1974, Alvarenga & Roppa; MN (ex-JCMC).

*Peruanocoris tuberculatus* Carvalho, 1953

Rev. Brasil. Biol. 13(1):34, fig. 1; H ♀, Vilcanota, Peru; NMNH (ex-JCMC).

*Phytocoris americanus* Carvalho, 1959

Arq. Mus. Nac. R. J. 48:190, n.n. for *Phytocoris angustulus* Reuter, 1909, Acta Soc. Sci. Fenn. 36(2):29, n. preocc. by *Phytocoris angustulus* Germar & Berendt, 1856, Bernst. befindl. organ. reste Vorw. 2(1):29.

*Phytocoris antennipilis* Carvalho & Ferreira, 1969

An. Acad. Brasil. Ci. 41(4):602, figs. 1–5; H ♂, Rio Los Moles, Coquimbo, Chile, XI.1961, 1300m, L. F. Peña col.; A ♀, P 1♀; NMNH (ex-JCMC).

*Phytocoris araucanus* Carvalho & Ferreira, 1969

An. Acad. Brasil. Ci. 41(4):604, figs. 6–10; H ♂, Las Cabras, Chile, III.1952, Kuschel col.; A ♀, P 8♂♂, 10♀♀; NMNH (ex-JCMC).

*Phytocoris aspersus* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(1):117, figs. 1–4; H ♂, Brasilien, Nova Teutônia, Fritz Plaumann, 30.I.1938; A ♀, P 10♂♂, 3♀♀; MN (ex-JCMC).

*Phytocoris bispilosus* Carvalho & Ferreira, 1969

An. Acad. Brasil. Ci. 41(4):605, figs. 11–15; H ♂, Atacama, Chile, IX.1952, Kuschel col.; A ♀, P 10♂♂, 3♀♀; NMNH (ex-JCMC).

*Phytocoris brasiliensis* Carvalho, 1955

Rev. Chil. Ent. 4:225, n.n. for *Phytocoris conspurcatus* (Carvalho, 1949) (as *Dionyza*), preocc. by *Phytocoris conspurcatus* Knight, 1920, Bull. Brook. Ent. Soc. 15:61.

*Phytocoris caledoniensis* Carvalho, 1959

Arq. Mus. Nac. R. J. 48:193, n.n. for *Phytocoris pallidus* Montrouzier, 1865, Ann. Soc. Linn. Lyon 2(11):235, n. preocc. by *Phytocoris pallidus* Rambur, 1842, Fauna And., p. 159.

*Phytocoris chilensis* Carvalho, 1955

Rev. Chil. Ent. 4:225, n.n. for *Phytocoris adspersus* Spinola, 1852, Hist. Fis. Pol. Chile 7:189, n. preocc. by *Phytocoris adspersus* Schilling, 1836, Ueber Arb. Schles. Ges. 1836:83.

*Phytocoris citrinoides* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(1):122, figs. 16–19; H ♂, Jussaral, Angra, E. do Rio, L. Trav. & Lopes, X.34, Brasil; A ♀, P 1♀; MN (ex-JCMC).

*Phytocoris cylapinus* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(1):124, figs. 20–23; H ♂, Paraguay, Caaguazu District, Estancia Primera, XI.1, 1932, R. F. Hussey; A ♀, P 2♀♀; NMNH (ex-JCMC).

*Phytocoris fluminensis* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(1):127, figs. 29–32; H ♂, Jussaral, Angra, E. do Rio, L. Travassos col., XI.1934; MN (ex-JCMC).

*Phytocoris guaranianus* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(1):128, figs. 33–36; H ♂, Parque Nacional da Serra dos Órgãos, Teresópolis, 1500–1700m, 14–22.IV.1947, Wygodz. col.; A ♀, P 7♂♂, 2♀♀; MN (ex-JCMC).

*Phytocoris lenti* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(1):130, figs. 37–40; H ♂, La Esperanza, A. Upaguy, XII.1943, Colombia; NMNH (ex-JCMC).

*Phytocoris* (P.) *lojaensis* Carvalho & Gomes, 1969

An. Acad. Brasil. Ci. 41(3):421, figs. 1–6; H ♂, Loja, Equador, III.1965, L. F. Peña col.; A ♀; NMNH (ex-JCMC).

*Phytocoris manauensis* Carvalho, 1983

Acta Amazon. 13(1):182, figs. 11–14; H ♂, Brasil, INPA (Instituto Nacional de Pesquisas da Amazonia), Manaus, AM (Amazonas), 14.VI.76; P 1♂, 1♀; INPA.

*Phytocoris mexicanus* Carvalho, 1959

Arq. Mus. Nac. R. J. 48:206, n.n. for *Phytocoris modestus* Reuter, 1908, Ann. Nat. Hofmus. 22:165, n. preocc. by *Phytocoris modestus* Blanchard, 1852, Hist. Fis. Pol. Chile 7:187.

*Phytocoris montrouzieri* Carvalho, 1955

Rev. Chil. Ent. 4:224, n.n. for *Phytocoris falleni* Montrouzier, 1865, Ann. Soc. Linn. Lyon, ser. 2 11:233, preocc. by *Phytocoris falleni* Hahn, 1834, Wanz. Ins. 2:89.

*Phytocoris obscuratus* Carvalho, 1959

Arq. Mus. Nac. R. J. 48:208, n.n. for *Phytocoris obscurus* Reuter, 1875, Not. Sallsk. Fauna Flora Fenn. 14:331, n. preocc. by *Phytocoris obscurus* Rambur, 1842, Fauna Andal., p. 103.

*Phytocoris organensis* Carvalho & Gomes, 1970

- Rev. Brasil. Biol. 30(1):131, figs. 41–44; H ♀, Parque Nacional da Serra dos Órgãos, Teresópolis, 1500/1700m, 18–22.IV.1947, Wygodz. col.; A ♂, P 3♀♀; MN (ex-JCMC).
- Phytocoris parandinus* Carvalho & Ferreira, 1969  
An. Acad. Brasil. Ci. 41(4):612, figs. 31–35; H ♂, Coquimbo, Chile, IX.1952, Kuschel col.; A ♀, P 20♂♂, 6♀♀; NMNH (ex-JCMC).
- Phytocoris pilosulus* Carvalho, 1959  
Arq. Mus. Nac. R. J. 48:162, n.n. for *Phytocoris pilosus* Reuter, 1901, Ofv. Finska Vet.-Akad. Forh. 43:162, n. preocc. by *Phytocoris pilosus* Boheman, 1852, Ofv. Finska Vet. Akad. Forh. 9(4):62.
- Phytocoris rioleonensis* Carvalho & Gomes, 1969  
An. Acad. Brasil. Ci. 41(3):423, figs. 7–11; H ♂, Rio Leon, 1700m, Ecuador, III.1965, L. F. Peña col.; P 1♂; NMNH (ex-JCMC).
- Phytocoris rubrovenosus* Carvalho & Ferreira, 1969  
An. Acad. Brasil. Ci. 41(4):615, figs. 41–45; H ♂, Chile, Santiago, Carvalho col.; A ♀, P 3♂♂, 3♀♀; NMNH (ex-JCMC).
- Phytocoris serranus* Carvalho & Gomes, 1970  
Rev. Brasil. Biol. 30(1):132, fig. 45; H ♀, Campos de Jordão, Est. São Paulo, 1600m, III.1945, Wygodzinsky leg.; P 1♀; MN (ex-JCMC).
- Phytocoris singularis* Carvalho & Ferreira, 1969  
An. Acad. Brasil. Ci. 41(4):617, figs. 46–50; H ♂, Zapallar, Chile, G. Mann col.; A ♀, P 1♀; NMNH (ex-JCMC).
- Phytocoris triannulatus* Carvalho & Ferreira, 1969  
An. Acad. Brasil. Ci. 41(4):618, figs. 51–55; H ♂, El Tofo, Coquimbo, Chile, IX.1952, Kuschel col.; A ♂, P 2♀♀; NMNH (ex-JCMC).
- Phytocorisca argentina* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(3):337, figs. 6–9; H ♂, Tucumán, Argentina, XII.1949, Wygodz.; A ♀, P 7♀♀, 6♂♂; MLP (ex-JCMC).
- Phytocorisca minima* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(3):339, figs. 10–13; H ♂, Minas Gerais, Brasil, Carmo do Rio Claro, col. Carvalho, 1945; A ♀; MN (ex-JCMC).
- Phytocorisca ocellata* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(3):340, figs. 14–17; H ♂, Angra, E. do Rio, Jussaral, X.1935, L. Travassos et Lopes; A ♀, P 3♀♀, 1♂; MN (ex-JCMC).
- Platybasicornis pilosus* Carvalho & Gomes, 1972  
Rev. Brasil. Biol. 32(2):153, fig. 5; H ♀, B. Horizonte, Minas Gerais, Brasil, Oscar Monte col.; A ♂, P 3♀♀; MN (ex-JCMC).
- Platybasicornis singularis* Carvalho & Gomes, 1972  
Rev. Brasil. Biol. 32(2):155, figs. 7–9; H ♂, Lafayette, Salta, Argentina, II.1961, Hayward col.; A ♀, P 5♂♂, 4♀♀; MLP (ex-JCMC).
- Platyscytus blantonii* Carvalho, 1955  
Rev. Brasil. Biol. 15(2):138, fig. 2; H ♂, Pt. Mensable, Los Santos Prov., Panama, 22.X.1952, F. S. Blanton col., cat. no. 62021; A ♀; NMNH.
- Platyscytus centralis* Carvalho & Fontes, 1967  
Rev. Brasil. Biol. 27(3):319, figs. 11–15; H ♀, Fazenda R. Franco, 6.III.1961, Brasil, M. T. J. & B. Bechyne col.; A ♂, P 3♀♀, 4♂♂; MN (ex-JCMC).



*Platyscytus hemiruber* Maldonado & Carvalho, 1981

Rev. Brasil. Biol. 41(2):386, figs. 1-5; H ♂, Panamá, Porto Rico, Jan. 1971, J. Maldonado; A ♀, P 3♀♀; NMNH.

*Platyscytus manauensis* Carvalho, 1982

Acta Amazon. 12(3):657, fig. 1; H ♀, Brasil, Amazonas, P. das Laranjeiras, 7.IX.81, Jorge Arias; INPA.

*Platyscytus peruvianus* Carvalho, 1976

Rev. Brasil. Biol. 36(3):718, figs. 6-9; H ♂, Peru, Yurac, 67 mi E of Tingo Maria, 16.XI.1954, E. I. Schlinger & E. S. Ross col.; CAS.

*Platyscytus rubrofasciatus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(2):207, fig. 7; H ♀, Jacareacanga, Pará, Brasil, IX.1979, F. R. Barbosa; MN (ex-JCMC).

*Platyscytus rufomaculatus* Carvalho, 1951

Soc. Sci. Fenn. Comm. Biol. 12(7):1, fig. 5; H ♂, Quilometro 18, Genú, Bahia, 6.XI.1950, Defesa Sanitaria Vegetal, no. 09064; A ♀, P 1♂, 1♀; MN (ex-JCMC).

*Platyscytus surinamensis* Carvalho & Rosas, 1965

Rev. Brasil. Biol. 25(1):56, figs. 5-8; H ♂, Paramaribo, Suriname, 15.X.1960, P. H. van Doesburg, Jr. col., on *Cecropia* sp.; A ♀, P 2♂♂, 2♀♀; NMNH (ex-JCMC).

*Platyscytus tucumanus* Carvalho, 1953

Rev. Brasil. Biol. 13(1):38, figs. 11-15; H ♂, Tucumán, Argentina, Wygodzinsky col., 1949; A ♀, P ♂, ♀; MLP (ex-JCMC).

*Platyscytus tucuruensis* Carvalho, 1981

Rev. Brasil. Biol. 41(1):14, fig. 6; H ♀, Tucuruí, Pará, Brasil, I.1979, M. Alvaranga; MN (ex-JCMC).

*Platyscytus venezuelanus* Carvalho & Maldonado, 1973

Rev. Brasil. Biol. 33(1):40, figs. 5-8; H ♂, Venezuela, Carabobo, Pataremo, Mts. sobre Urrera caracasana, Pringamosa, 12.VII.1968, J. Maldonado C.; A ♀, P 2♂♂; NMNH (ex-JCMC).

*Platytomatocoris brasiliensis* Carvalho, 1946

Livro hom. d'Almeida 10:125, figs. 1, 4-7; H ♂, Chapada, M. Grosso; A ♀; MN (ex-JCMC).

*Platytylusca peruvianus* Carvalho, 1976

Rev. Brasil. Biol. 36(3):683, figs. 1-4; H ♂, Peru, Monson Valley, Tingo Maria, IX.23.1954, E. I. Schlinger & E. S. Ross col.; CAS.

*Platytyloides cartagenus* Carvalho & Fontes, 1971

Rev. Brasil. Biol. 31(1):18, figs. 1-5; H ♂, Sabanilla, Columbien, C. Gagzo leg., 8.VI.1905 ded 5.VIII.1905; A ♀, P 3♂♂, 11♀♀; MZU.

*Platytyloides columbiensis* Carvalho & Fontes, 1972

Rev. Brasil. Biol. 32(2):221, figs. 1-4; H ♂, Rep. Colombia, 1420m, Prov. Cundinamarca, Monterredondo, 1.II, leg. J. Foerster, 1959; A ♀, P 2♂♂; NMNH (ex-JCMC).

*Platytylus bisignatus* Carvalho & Schaffner, 1976

Rev. Brasil. Biol. 35(4):721, figs. 31-34 (1975); H ♂, Mexico, Morelos, 4.4 mi Ee. Cuernavaca, July 6-8, 1974, Clark, Murray, Ashe, Schaffner (TAMU); A ♀, P 2♂♂, 3♀♀; NMNH.

*Platytylus bolivianus* Carvalho & Schaffner, 1976

- Rev. Brasil. Biol. 35(4):723, figs. 35–38 (1975); H ♂, Rio Beni, Lara, J. C. M. Carvalho col., 1951; A ♀; NMNH (ex-JCMC).
- Platytylus mexicanus* Carvalho & Schaffner, 1976  
Rev. Brasil. Biol. 35(4):725, figs. 40–43 (1975); H ♀, 35 mi. sw Cintalapa, Chis., Mex., VI.25.65, Burke, Meyer, Schaffner (TAMU); A ♂, P 9♂♂, 19♀♀; NMNH.
- Platytylus miniatus* Carvalho & Schaffner, 1976  
Rev. Brasil. Biol. 35(4):726, fig. 44 (1975); H ♀, Mexico, Mor., Cuernavaca, VI.1959, N. L. H. Krauss; NMNH.
- Platytylus notatus* Carvalho & Schaffner, 1976  
Rev. Brasil. Biol. 35(4):727, figs. 45–48 (1975); H ♀, 5 mi. w La Huacana, Mich., Mex., VII.17.66, P. M. & P. K. Wagner (TAMU); A ♂, P 6♂♂, 6♀♀; NMNH.
- Platytylus proximus* Carvalho & Schaffner, 1976  
Rev. Brasil. Biol. 35(4):730, figs. 50–53 (1975); H ♂, Mexico, A ♀; NMNH (ex-JCMC).
- Platytylus singularis* Carvalho & Schaffner, 1976  
Rev. Brasil. Biol. 35(4):732, figs. 54–58 (1975); H ♂, Los Mayos, Sinaloa, Mex., VII.24.52, J. D. Lattin col. (CIS); A ♀, P 1♂, 1♀ ex.; CAS.
- Platytylus seminigroides* Carvalho & Fontes, 1970  
Studia Ent. 13(1–4):458, figs. 39–42; H ♂, Misiones, Argentina, Dep. Concep., Sta. Maria, M. J. Viana, 47808; MLP (ex-JCMC).
- Plaumannocoris rarus* Carvalho, 1947  
Rev. Brasil. Biol. 7(2):258, figs. 8–11; H ♀, Nova Teutônia, Sta. Catarina, F. Plaumann leg., XII.1945; MN (ex-JCMC).
- Poeas capichaba* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):169, figs. 1–4, 48; H ♂, Estr. Rio-Bahia, Km 965, Motel da Divisa, 900m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa col.; P 2♂♂, 6♀♀; MN (ex-JCMC).
- Poeas cipoa* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):177, figs. 23–26, 42 [as “*Taedia cipoa*”]; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 900m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa col.; A ♀, P 5♀♀, 1♂; MN (ex-JCMC).
- Poeas nigra* Carvalho, 1977  
Rev. Brasil. Biol. 37(1):20, figs. 8–12; H ♂, Corcovado, Rio de Janeiro, Brasil, C. A. Seabra col., X.1974 & XI.1975; A ♀, P 6♂♂, 11♀♀; MN (ex-JCMC).
- Poeas peruana* Carvalho, 1976  
Rev. Brasil. Biol. 35(2):170, figs. 5–8, 47; H ♂, Machu Pichu, H. Malkin col., 6.IX.1964, Peru, 2000m; A ♀, P 2♀♀, 1♂; NMNH (ex-JCMC).
- Poeas reuteri alvarenga* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):173, figs. 9–11, 39; H ♂, Sinop, Rio Teles Pires, Estrada Cuiaba-Santarem, Km 500, Mato Grosso, Brasil, IX.1974, M. Alvarenga & O. Roppa col.; A ♀, P 52♂♂♀♀; MN (ex-JCMC).
- Poeas reuteri atlantica* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):174, figs. 12–15, 40; H ♂, Brasil, Nova Teutônia, Santa Catarina, 27°11' S, 52°23' W, XI.1971, Fritz Plaumann col.; A ♀, P ♂, ♀; MN (ex-JCMC).
- Poeas reuteri caatinga* Carvalho, 1975

- Rev. Brasil. Biol. 35(2):175, figs. 16–19, 44; H ♂, Casa Nova, Pernambuco, Brasil (em caatinga), J. C. M. Carvalho col., IV.1975; A ♀, P 4♂♂, 3♀♀; MN (ex-JCMC).
- Poeas reuteri chapada* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):176, figs. 20–22, 41; H ♂, Chapada dos Guimarães, Mt., XI.1967, M. Alvarenga col.; A ♀, P 7♂♂♀♀; MN (ex-JCMC).
- Poeas serrana* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):179, figs. 31–34, 45; H ♂, Itatiaia, Estado do Rio, 700m, E. Rio, Brasil, 13.XI.1938, J. F. Zikan; P 7♂♂, 5♀♀; MN (ex-JCMC). (Note: For the original publication of this species a holotype was selected and illustrated (p. 180, figs. 31–34) but not properly reported in the text. The locality data for the holotype and the numbers of paratypes are correctly given in the citation above.)
- Poeas sooretama* Carvalho, 1980  
Rev. Brasil. Biol. 42(2):304, figs. 16–19; H ♂, Sooretama, E. S. (Estado do Espírito Santo), Brasil, XII.59, Zajciw col.; P 2♂♂; MN (ex-JCMC).
- Poeas tucumana* Carvalho, 1975  
Rev. Brasil. Biol. 35(2):181, figs. 35–38, 46; H ♂, Tucumán, Republica Argentina, XII.1949, Wygodzinsky col.; A ♀, P 3♂♂, 2♀♀; MLP (ex-JCMC).
- Poecilocapsus citrinus* Carvalho & Hussey, 1954  
Occas. Papers Mus. Zool. Mich. 552:8, figs. 2–5; H ♂, Estancia Primera, Caaguazu District, Paraguay, 23.XII.1931, R. F. Hussey coll., taken on *Mimosa daleoides* growing on the open campo; A ♀, P 2♂♂, 8♀♀; UNMZ.
- [*Polyemerus rubescens*—see *Polyemerus rubescens*]
- Polyemerus amazonicus* Carvalho, 1976  
Rev. Brasil. Biol. 36(4):767, figs. 10–13; H ♂, Cucui, Rio Negro, Amazonas, J. C. M. Carvalho col., 1951; MN (ex-JCMC).
- Polyemerus carpintero* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(3):526, figs. 14–17; H ♂, Republica Argentina, Merlo, San Luiz, 1972; MACN.
- Polyemerus chilensis* Carvalho & Gomes, 1969  
Rev. Brasil. Biol. 29(4):479, figs. 1–4; H ♂, Pemehue, Chile, Gutierrez col., 11.I.1946; A ♀, P 1♂, 7♀♀; NMNH (ex-JCMC).
- Polyemerus ecuadorensis* Carvalho & Gomes, 1968  
An. Acad. Brasil. Ci. 40(4):536, fig. 19; H ♂, Coca, V.1965, L. F. Peña col.; A ♀, P 5 exemplares; NMNH (ex-JCMC).
- Polyemerus modestus* var. *nigriscutis* Carvalho & Gomes, 1969  
Rev. Brasil. Biol. 29(4):482.
- Polyemerus rubescens* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):52, figs. 13–16 (1973) [as “*Polyemerus*” *rubescens*]; H ♂, 2 mi E Ixtlan del Rio, Nay., Mex., VIII.21.1964, H. R. Burke & J. Apperson; A ♀, P 5♂♂, 9♀♀; NMNH.
- Porophoroptera excellens* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:52, figs. 82–88, 126; H ♂, Queensland, Bald Mountain area, 1000–1200 m, via Emu Vale, 27–31.I.1972, S. R. Monteith; A ♀, P 2♂♂; QM.
- Porpomiris campinensis* Carvalho, 1947

Bol. Mus. Nac., Zool. 77:4, figs. 15–19; H ♂, Campinas, S. Paulo, 1940 (H. Parker col.); A ♀, P 3♂♂, 3♀♀; MACN.

*Prepops anasueliae* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(2):367, figs. 1–4; H ♀, Paraguay, Caaguazú District, Estancia Primera, 24.XII.1931, R. F. Hussey; A ♂, P 1♂; NMNH (ex-JCMC).

*Prepops bahiensis* Carvalho, 1975

Rev. Brasil. Biol. 35(3):558, fig. 13; H ♀, Estrada Rio-Bahia, Km 965, Motel da Divisa, 690m, Encruzilhada, Bahia, Brasil, I.1972, Seabra & Roppa col.; P 1♀; MN (ex-JCMC).

*Prepops bolivianus* Carvalho & Fontes, 1969

An. Acad. Brasil. Ci. 41(2):262, figs. 5–8; H ♀, Tacu, Buena Vista, Ichilo, Bolivia, III.1955, Prosen; A ♂, P 1♀; NMNH (ex-JCMC).

*Prepops canelae* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):794, figs. 5–8; H ♂, Chapada dos Guimarães, Mt., XI.1963, M. Alvarenga col.; A ♀, P 1♂, 1♀; MN (ex-JCMC).

*Prepops caracensis* Carvalho, 1975

Rev. Brasil. Biol. 34(4):467, figs. 1–4 (1974); H ♂, Serra do Caraca, Minas Gerais, F. M. Oliveira col.; A ♀, P 3♂♂, 1♀♀; MN (ex-JCMC).

*Prepops carioca* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):794, figs. 9–12; H ♂, Corcovado, Guanabara, Brasil, 19.IX.1967, Alvarenga & Seabra; P 3♂♂; MN (ex-JCMC).

*Prepops catarinensis* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):797, figs. 13–16; H ♀, Brasilien, Nova Teutônia, 27°11' S, 52°23' L, Fritz Plaumann, 18.XI.1938; P 1♂; MN (ex-JCMC).

*Prepops championi* Carvalho, 1952

Bol. Mus. Nac. R. J. 118:16, n.n. for *Prepops univittata* (Distant, 1883), [as *Resthenia*] Biol. Centr. Amer., Rhyn. Het. 1:255, n. preocc. by *Resthenia univittata* Berg, 1879, Hem. Arg., p. 281 [republished in 1880, An. Soc. Ci. Arg. 9(1):19].

*Prepops cordobanus* Carvalho & Fontes, 1969

An. Acad. Brasil. Ci. 41(4):575, figs. 1–4; H ♂, Cordoba, Yacanto de San Javier, 23.I.1958, Willink-Tonsic; A ♀, P 6♀♀, 1♂; MLP (ex-JCMC).

*Prepops cruciferoides* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):799, figs. 21–24; H ♀, Brasilien, Nova Teutônia, 27°11' S, 52°23' L, Fritz Plaumann, XII.1944; A ♀, P 5♂♂, 3♀♀; MN (ex-JCMC).

*Prepops cubanus* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 34(4):625, figs. 5–9 (1974); H ♂, Havana, Cuba, Baker col.; A ♀, P 2♂♂; NMNH.

*Prepops diamantinensis* Carvalho, 1984

Rev. Brasil. Biol. 44(1):105, figs. 23–26; H ♂, Diamantino, Mato Grosso, Faz. S. Joao, Km 20, Br 163, Roppa col.; P 3♂♂, 2♀♀; MN.

*Prepops diminutus* Carvalho & Fontes, 1973

Rev. Brasil. Biol. 33(4):539, figs. 1–4; H ♂, Novo Mexico, Otero Co., Monumento Nacional de "White Sands", altitude 4,100 pes, 20.VIII.1970, J. R. & M. N. Sweet; A ♀, P 8♀♀; NMNH.

*Prepops fuzai* Carvalho & Fontes, 1973



Rev. Brasil. Biol. 33(4):540, figs. 5–8; H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N, 52°23' W, IV.1971, Fritz Plaumann; A ♀, P 1♀; MN (ex-JCMC).

*Prepops frontosus* Carvalho, 1975

An. Acad. Brasil. Ci. 46(2):309, figs. 17–20 (1974) [species heading misspelled “prontosus”]; H ♂, Peru, Manson Valley, Tingo Maria. X–XII.1934, E. I. Schlinger & E. S. Ross collectors; A ♀, P 2♂♂; CAS.

*Prepops guaranianus* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42:374, figs. 29–32; H ♂, Buenos Aires, Medanos, 11.XI.1946; A ♀, P 4♀♀; MLP (ex-JCMC).

*Prepops huanucanus* Carvalho, 1975

An. Acad. Brasil. Ci. 46(2):308, fig. 16 (1974); H ♀, Peru, SW Las Palmas, Huanuco, 100m, IX.17.1954, E. I. Schlinger & E. S. Ross collectors; P 3♀♀; CAS.

*Prepops insitivoides* Carvalho & Fontes, 1969

An. Acad. Brasil. Ci. 41(2):265, figs. 13–16; H ♀, Est. Paraná, Morretes, 25.951, Mus. Paranaense, R. Lange leg.; A ♂; MN (ex-JCMC).

*Prepops itatiaiensis* Carvalho & Fontes, 1968

Rev. Brasil. Biol. 28(1):32, figs. 7, 7a, 8–11; H ♀, Maromba, Itatiaia, 1952, Seabra col.; A ♀, P 5♀♀, 1♂; MN (ex-JCMC).

*Prepops itatiaiensis* var. *unicolor* Carvalho & Fontes, 1968

Rev. Brasil. Biol. 28(1):32.

*Prepops lineatus* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 35(3):559, fig. 14; H ♀, Mexico, Oaxaca, 7, 7 mi. s. Ejutla, 20.VII.1974, Clark, Murray, Ashe & Schaffner; NMNH.

*Prepops lopesi* Carvalho & Fontes, 1973

Rev. Brasil. Biol. 33(4):542, figs. 9–12; H ♂, Nova Teutônia, Santa Catarina, Brasil, 27°11' N, 52°23' W, IV.1971, Fritz Plaumann; MN (ex-JCMC).

*Prepops maldonadoi* Carvalho & Fontes, 1973

Rev. Brasil. Biol. 33(4):543, figs. 13–16; H ♂, 12 milhas sudoeste, Provincia La Vega, Republica Dominicana, 8.VIII.1967, J. C. Schaffner; NMNH.

*Prepops minensis* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(2):377, figs. 41–44; H ♂, M. Gerais, Brasil, Vicosa, IV.1944, col. Carvalho; P 1♂; MN (ex-JCMC).

*Prepops mimosus* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):801, figs. 29–32; H ♂, Paraguay, Villarrica, F. H. Schade; P 2♂♂; NMNH (ex-JCMC).

*Prepops nigrus* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):802, figs. 33–36; H ♂, Argentina, Prov. Santa Cruz, Puerto Bandera, Lago Argentino, 26.I.1962, T. Cekalovic col.; A ♀, P 1♂; MLP (ex-JCMC).

*Prepops notabilis* Carvalho & Fontes, 1968

Rev. Brasil. Biol. 28(1):31, figs. 2–6; H ♂, Stgo. del Estero, Tipiro, 23.I.1959, Comisión Lillo; A ♀, P 26♂♂, 13♀♀; IML.

*Prepops oaxacaensis* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 34(4):626, figs. 10–14 (1974); H ♂, Mexico, Oaxaca, 2,7 mi. NW El Cameron, 24.VII.1973, taken at light, Mastro & Schaffner; A ♀; NMNH.

*Prepops occidentalis* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 34(4):627, figs. 15–18 (1974); H ♂, Mexico, Sinaloa, 2.5 mi. N Mazatlan, VIII.12.1970, M. Wasbauer coll. Berkeley, California, U. S. A.; P ♂; CAS.

*Prepops paraensis* Carvalho & Fontes, 1971

Rev. Brasil. Biol. 31(3):324, figs. 23–26; H ♂, Pará, Brasil, Baker, Mus. Zool., Helsinzi; A ♀, P 1♂; MZU.

*Prepops paraguayensis* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):803, figs. 37–40; H ♂, Paraguay, Horqueta, 27.I.1934, Alberto Schulze; A ♀, P 2♂♂, 8♀♀; NMNH (ex-JCMC).

*Prepops paranaensis* Carvalho & Fontes, 1969

An. Acad. Brasil. Ci. 41(2):269, figs. 26–29; H ♂, Paraná, Brasil, Staviarski col., '50, JCMC col.; A ♀, P 30♂♂♀♀; MN (ex-JCMC).

*Prepops paulistanus* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):804, figs. 41–44; H ♂, Campos de Jordão, Est. de São Paulo, 1600m, III.1945, Wygodzinsky leg.; P 1♂; MN (ex-JCMC).

*Prepops prepopsoides* Carvalho, 1975

Rev. Brasil. Biol. 34(4):468, figs. 5–8 (1974); H ♂, Estrada Rio-Bahia, KM 965, Motel da Divisa, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa col.; A ♀, P 1♀, 4♂♂; MN (ex-JCMC).

[*Prepops prontosus*—see *Prepops frontosus*]

*Prepops quadriguttatus* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):806, fig. 49; H ♀, Olmos, 21.III.1967 (Hierbas), Korytkowashi; NMNH (ex-JCMC).

*Prepops roppai* Carvalho, 1975

Rev. Brasil. Biol. 34(4):469, figs. 9–12 (1974); H ♂, Estrada Rio-Bahia, KM 965, Motel da Divisa, 960m., Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa; A ♀, P 1♀; MN (ex-JCMC).

*Prepops rufocapitis* Carvalho & Fontes, 1971

An. Acad. Brasil. Ci. 43(3–4):799, figs. 30–33; H ♂, Amazon floden, Mus. Moskou, Mus. Zool. Helsinki; A ♀; MZU.

*Prepops saltensis* Carvalho & Fontes, 1970

An. Acad. Brasil. Ci. 42(4):807, figs. 50–53; H ♀, 30 mi. S of Jujuy, R. A., 14.XI.51, Ross & Michelbacher collectors; A ♂, P 2♂♂, 1♀; MLP (ex-JCMC).

*Prepops schaffneri* Carvalho & Fontes, 1973

Rev. Brasil. Biol. 33(4):544, figs. 17–20; H ♂, 1 milha noroeste de Ayutla, Queretaro, Mexico, 24.VII.1970, coligido em luz, a noite, Murray, Phelps, Hart, Schaffner; A ♀, P 1♂, 8♀♀; NMNH.

*Prepops serranus* Carvalho & Fontes, 1969

An. Acad. Brasil. Ci. 41(4):577, figs. 9–12; H ♂, Petrópolis, E. do Rio, Le Vallon Alt. Mosella, 24.I–23.II.1956, D'Albuquerque col.; MN (ex-JCMC).

*Prepops similaris* Carvalho & Fontes, 1973

Rev. Brasil. Biol. 33(4):545, figs. 21–24; H ♂, 5 mi. Cuencame, Durando, Mexico, VIII.12.1965, J. Burke & J. Meyer; A ♀, P 5♂♂, 2♀♀; NMNH.

*Prepops singularis* Carvalho & Fontes, 1969

An. Acad. Brasil. Ci. 41(4):578, fig. 13; H ♀, coll. Breyer, Rep. Argentina, Patquia; MLP (ex-JCMC).

- Prepops subandinus* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(3):527, figs. 18–21; H ♂, Republica Argentina, Tucuman, 4300m, 1.XI.1964, W. Weyrauch, ex-col. Weyrauch; IML.
- Prepops subsimilis* var. *alfa* Carvalho & Fontes, 1969  
An. Acad. Brasil. Ci. 41(2):272.
- Prepops subsimilis* var. *beta* Carvalho & Fontes, 1969  
An. Acad. Brasil. Ci. 41(2):272.
- Prepops subsimilis* var. *delta* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):382.
- Prepops subsimilis* var. *eta* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):383.
- Prepops subsimilis* var. *gamma* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):382.
- Prepops subsimilis* var. *iota* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):383.
- Prepops subsimilis* var. *teta* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):383.
- Prepops subsimilis* var. *zeta* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):383.
- Prepops teutonianus* Carvalho & Fontes, 1969  
An. Acad. Brasil. Ci. 41(2):272, figs. 38–41; H ♂, Brasilien, Nova Teutônia, Fritz Plaumann, XII.1944; A ♀, P 12♂♂♀; MN (ex-JCMC).
- Prepops trilineatus* Carvalho & Fontes, 1970  
An. Acad. Brasil. Ci. 42(4):809, figs. 58–61; H ♂, Tucumán, Argentina, XII.1949, Wygodz.; A ♀, P 3♀♀, 2♂♂; MLP (ex-JCMC).
- Prepops trivittatus* Carvalho & Fontes, 1969  
An. Acad. Brasil. Ci. 41(4):578, figs. 14–17; H ♂, Tucumán, Argentina, XII.1949, Wygodz. col.; A ♀, P 2♀♀, 1♂; MLP (ex-JCMC).
- Prepops tucumanensis* Carvalho & Fontes, 1969  
Ac. Acad. Brasil. Ci. 41(2):274, figs. 42–45; H ♂, Tucumán, Argentina, XII.1949, Wygodzinsky leg.; A ♀, P 27♂♂♀; MLP (ex-JCMC).
- Prepops tupianus* Carvalho & Fontes, 1970  
An. Acad. Brasil. Ci. 42(4):810, figs. 62–65; H ♂, Angra, Est. do Rio, Jussaral, X.1935, L. Trav. & Lopes; A ♀, P 6♂♂, 11♀♀; MN (ex-JCMC).
- Prepops turrialbanus* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 34(4):629, figs. 19–22 (1974); H ♂, Turrialba, Costa Rica, 22.V.1951, O. L. Cartwright coll.; A ♀, P ♂; NMNH.
- Prepops univittatoides* Carvalho & Fontes, 1970  
An. Acad. Brasil. Ci. 42(2):384, figs. 71–74; H ♂, Paraná, Brasil, Staviarsski, 4.52, J.C.M. Carvalho, col.; A ♀, P 11♂♂♀; M.N.
- Prepops variabilis* Carvalho & Fontes, 1970  
An. Acad. Brasil. Ci. 42(4):812, figs. 66–69; H ♂, Tucumán, R. A., 30.10.1948, Wigodzinsky col.; A ♀, P 3♂♂, 1♀; MLP (ex-JCMC).
- Prepops vianai* Carvalho & Fontes, 1970  
An. Acad. Brasil. Ci. 42(4):813, figs. 70–73; H ♂, Misiones, Argentina, Dep. Concep. Sta. Maria, M. J. Viana; A ♀, P 1♀; MLP (ex-JCMC).

- Prepops wallersteini* Carvalho & Fontes, 1970  
An. Acad. Brasil. Ci. 42(2):385, figs. 75–78; H ♀ Cordoba, Argentina, Dep. de Calamuchita, Sauce, XII. 1938, Manuel C. Viana; A ♂; MLP (ex-JCMC).
- Prepops xavantinoidei* Carvalho & Fontes, 1972  
Rev. Brasil. Biol. 32(2):222, figs. 5–8; H ♂, Sabnilla, Columben, C. Gagzo leg., 8.VI.1905, ded 5.VIII.1905; A ♀, P 1♂, 4♀♀; NMNH (ex-JCMC).
- Prepops xavantinus* Carvalho & Fontes, 1969  
An. Acad. Brasil. Ci. 41(4):580, figs. 22–25; H ♂, Goiás, Brasil, Aragarças, Carvalho col.; A ♀, P 5♀♀, 1♂; MN (ex-JCMC).
- Prepops zetterstedti* var. *alfa* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):388.
- Prepops zetterstedti* var. *beta* Carvalho & Fontes, 1970  
Rev. Brasil. Biol. 42(2):388.
- Prepopsella pilosa* Carvalho, 1975  
An. Acad. Brasil. Ci. 46(2):304, figs. 1–4 (1974); H ♂, Estrada Rio-Bahia, KM 965, Motel da Divisa, 960m, Encruzilhada, Bahia, Brasil, XI.1973, Seabra & Roppa col.; MN (ex-JCMC).
- Prepopsoides binotatus* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 34(3):297, fig. 5 (1974); H ♀, Mexico, Oax., Puerto Angel, 31.VII.1965, A. B. Lau; NMNH.
- Probosciodocoris castaneus* Carvalho, 1953  
Bol. Mus. Nac., Zool. 102:5, figs. 9–11; H ♂, Reserve des Banes, B. Holas C. diovice; A ♀, P 1♂, 2♀♀; IFAN.
- Probosciodocoris dahomeyensis* Carvalho, 1953  
Bol. Mus. Nac., Zool. 120:6, fig. 2; H ♀, Zagnanado, Dahomey, 8.V.1950, A. Villiers col.; P 1♀; IFAN.
- Probosciodocoris piceus* Carvalho, 1953  
Bol. Mus. Nac., Zool. 120:4, figs. 6–8; H ♂, Moka & Basile, Fernando Poo, XII.1951, Dkeyser, Lepesme & A. Villiers; A ♀, P 1♂ 1♀; IFAN.
- Prodromopus nigrus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:83, figs. 179–182; H ♂, New Guinea, Neth., Waris, SE Hollandia, 450–500 m, VIII.24–31.1959, T. C. Maa; P 1♂; BPBM.
- Prodromus melanonotus* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1–2):109, figs. 6A, F, J–K; H ♂, Gold Coast, Qm. nr. of Cape Coast, 9.IX.1943, H. E. Box coll., H. 1043; A ♀, P 1♂; BMNH.
- Proneella boliviana* Carvalho, 1960  
Arq. Mus. Nac. R. J. 50:50, figs. 2, 8, 11–14; H ♂, El Palmar, Chapare Coxabamba, Bolivia, 1000m, 18–10.I.1958, Monros & Wygodzinsky; A ♀, P 3♂♂, 3♀♀; NMNH (ex-JCMC).
- Proneella peruana* Carvalho, 1960  
Arq. Mus. Nac. R. J. 50:51, figs. 3, 15–18; H ♂, Marcapata, Peru; A P 3♀♀; NMNH (ex-JCMC).
- Protaedia conspurcata* Carvalho, 1975  
Rev. Brasil. Biol. 35(3):501, figs. 2–7; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI,1972, Seabra & Roppa col.; P 1♂; MN (ex-JCMC).



*Proxenetus serranus* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):176, figs. 1-5 (1973); H ♂, S. Bocaina, 1650 m., S. J. Barreiro, S P Brasil, M. Alvarenga col.; P 2♂♂; MN (ex-JCMC). (Note: The holotype data given above was accidentally omitted from the original description.)

*Psallops ponapensis* Carvalho, 1956

Ins. Micronesia 7(1):44, fig. 24a, d, g; H ♂, Mt. Pairot, Ponape, summit, 2000 ft., III.1948, H. S. Dybas; A ♀, P 1♂; NMNH.

*Psallops yapensis* Carvalho, 1956

Ins. Micronesia 7(1):44, fig. 25; H ♂, hill behind Yaptown, Yap I, light trap, 3.XII.1952, J. L. Gressitt; NMNH.

*Psallus albipesinus* Carvalho, 1958

Arq. Mus. Nac. R. J. 45:113, n.n. for *Psallus albipes* (Jakovlev, 1877), [as *Apo-cremnus*] Bull. Soc. Nat. Mosc. 52(2):298, preocc. by *Atractotomus albipes* Fieber, Wien. Ent. Monat. 2:334, a junior syn. under *Psallus obscurellus*.

*Psallus incaicus* Carvalho & Gomes, 1968

An. Acad. Brasil. Ci. 40(4):533, figs. 13-16; H ♂, Quito, Equador, IX.1962, JCMC col.; A ♀, P 16 "exemplares"; NMNH (ex-JCMC).

*Psallus longirostris* Carvalho, 1968

Proc. Cal. Acad. Sci., Fourth Ser. 36(7):158, figs. 9b, 11; H ♂, Santa Cruz Island, Academy Bay, Darwin Research Station, 21.I.1964 (Cavagnaro & Schuster), sweeping coastal plants; A ♀, P 23♂♂, 38♀♀; CAS.

*Psallus usingeri* Carvalho, 1968

Proc. Cal. Acad. Sci., Fourth Ser. 36(7):162, fig. 3; H ♂, Galápagos Archipelago, Bela Vista, Santa Cruz, 4.II.1964, Usinger; P 2♂♂; CAS.

*Pseudobryocoris catarinensis* Carvalho, 1948

An. Acad. Brasil. Ci. 20(1):101, figs. 5-8; H ♂, Nova Teutônia, Santa Catarina, XII.1944, F. Plaumann col., A 1♀, P 8♀♀, 4♂♂; MN (ex-JCMC).

*Pseudobryocoris colcasicus* Carvalho, 1948

An. Acad. Brasil. Ci. 20(1):102, figs. 9-13; H ♂, San Pedro de Montes de Oca, 8-15-36, C. H. Ballou col., Costa Rica: NMNH.

*Pseudocarnus paulistanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):383, figs. 16-19 (1984); H ♂, Campos do Jordão, São Paulo, XII.1963, Seabra & Oliveira; P 1♂; MN.

*Pseudocarnus sulinus* Carvalho & Gomes, 1972

An. Acad. Brasil. Ci. 44(1):152, figs. 22-25; H ♂, Brasilien, Nova Teutônia, 27°11' S, 52°23' L, XI.1944, Fritz Plaumann; A ♀, P 6♂♂, 11♀♀; MNM (ex-JCMC).

*Pseudocarnus tijucanus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):385, fig. 20 (1984); H ♀, Corcovado, Guanabara, Brasil, X.75, C.A. Seabra; P 11♀♀; MN.

*Pseudodoniella pacifica* China & Carvalho, 1951

Bull. Ent. Res. 42(2):467, figs. 1, 2, 4C, F; H ♀, Lowlands Experimental Station, Keravat, New Britain, 7.X.1950 (G. S. Dun); A ♂, P 2♂♂, 1♀; BMNH.

*Pseudoloxops lindrothi* Carvalho, 1980

Ent. Gen. 6(2):375, fig. 1; H ♂, Sri Lanka, Gal District, Kannelyia Jungle, 28 July, 1973, 300 ft, Ginter Ekis, at black light; NMNH.

*Pseudoloxops palauensis* Carvalho, 1956

Ins. Micronesia 7(1):63, figs. 35b, 37b–c; H ♂, east Ngatpang, 65 m, Babelthuaap I., Palau Is., 10.XII.1952, Gressitt; A ♀, P 3♂♂, 3♀♀; NMNH.

*Pseudoloxops trukensis* Carvalho, 1956

Ins. Micronesia 7(1):65, figs. 35d, 37a, 38a; H ♂, Mt. Unibot, Tol (Ton) I. Truk, 31.XII.1952, J. L. Gressitt; A ♀, P 3♂♂, 1♀; NMNH.

*[Pycnoderes palustris—see Pycnoderes palustris]**Pycnoderes amapaensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):281, figs. 56–59 (1984); H ♀, Porto Platon, Brasil, Amapá, J. & B. Bechyné col.; P 5♂♂, 2♀♀; MN.

*Pycnoderes brasiliensis* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):471, fig. 37; H ♀, Minas Gerais, Brasil, Viçosa, XI.1944, Carvalho col.; A ♂, P 3♀♀; MN (ex-JCMC).

*Pycnoderes columbiensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):282, fig. 60 (1984); H ♂, Colombia, X.70, Putumayo, Boris Malkin; NMNH.

*Pycnoderes ecuadorensis* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):472, figs. 38–42; H ♂, Catamayo, Ecuador, III.1963, L. F. Peña col.; A ♀, P 9♂♂, 6♀♀; NMNH (ex-JCMC).

*Pycnoderes embolatus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):282, fig. 61 (1984); H ♀, Serra do Caraça, Minas Gerais, Brasil; NM.

*Pycnoderes explanatus* Carvalho & Rosas, 1962

Rev. Brasil. Biol. 22(3):249, figs. 7–9; H ♂, Angra dos Reis, Japuhya, II.1944, Wygodzinsky col.; A ♀, P 3♂♂, 6♀♀; MN (ex-JCMC).

*Pycnoderes grandis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):283, figs. 62–65 (1984); H ♀, Machupichu, Peru, Boris Malkin, 6.II.1964; P 3♂♂, 2♀♀; NMNH.

*Pycnoderes guaranianus* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):473, figs. 43–45; H ♂, Satipo, Peru, VI.1943. Papriski; A ♀, P 9♂♂, 7♀♀; NMNH (ex-JCMC).

*Pycnoderes itatiaiensis* Carvalho, 1980

Rev. Brasil. Biol. 40(3):437, figs. 11–14; H ♂, Brasil, Rio de Janeiro, Parque Itatiaia, Jan. 1978, Carvalho & Schaffner col.; P 4♂♂, 15♀♀; MN (ex-JCMC).

*Pycnoderes palustris* Carvalho, 1951

Soc. Sci. Fenn. Comm. Biol. 12(7):1, figs. 1–4; H ♂, Carmo do Rio Claro, Minas Gerais, Fazenda Renascença, no brejo acima da usina de energia eléctrica, J. C. M. Carvalho col., VII.1947; A ♀, P 23♀♀, 3♂♂; MN (ex-JCMC).

*Pycnoderes sixeonotoides* Carvalho & Hussey, 1954

Occas. Papers Mus. Zool. Mich. 552:4, figs. 1, 6–8; H ♂, Carmo de Rio Claro, Minas Gerais, Brasil, 1947 (JCMC col); A ♀, P 12♂♂, 47♀♀; MN (ex-JCMC).

*Pygophorisca bituberculata* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):239, figs. 5–10; H ♂, Pirapora, Minas Gerais, Brasil, XI.1976, Seabra, Monne & Roppa; P 5♂♂; MN (ex-JCMC).

*Queretarius hialinipennis* Carvalho & Schaffner, 1974

- Rev. Brasil. Biol. 33(Supl.):28, figs. 11–15 (1973); H ♂, 14 miles West of Landa de Matamoros, Queretaro, Mexico, 23.VII.1970, at light, Schaffner, Murray, Phelps, Hart; A ♀, P 1♂, 2♀♀; NMNH.
- Quichuamiris cochabambensis* Carvalho, 1975  
An. Acad. Brasil. Ci. 46(2):326, figs. 6–9 (1974); H ♂, Cochabamba, Bolivia, 1969, J. C. M. Carvalho col.; A ♀, P 1♀; NMNH (ex-JCMC).
- Quitocoris quitoensis* Carvalho & Gomes, 1969  
An. Acad. Brasil. Ci. 41(3):426, figs. 19–24; H ♂, Quito, IX.1962, Ecuador, JCMC col.; A ♀, P 11♂♂, 5♀♀; NMNH (ex-JCMC).
- Ragmus srilankensis* Carvalho, 1976  
Rev. Brasil. Biol. 36(2):318, figs. 1–8; H ♂, Sri Lanka, Colombo Col. Dist. West Prov. 28 Jan. 75, K. V. Krombein, 12875 A, cell 2; A ♀, P 39♂♂♀, nymphs; NMNH.
- Ragwelellus (R.) bismarckensis* Carvalho & Wallerstein, 1979  
Rev. Brasil. Biol. 39(2):473, figs. 1–5; H ♂, Bismarck Arch., New Britain, SW of Keravat, Dec. 13.1959, T. C. Maa; BPBM.
- Ragwelellus (N.) gressitti* Carvalho & Wallerstein, 1979  
Rev. Brasil. Biol. 39(2):476, figs. 11–15; H ♀, New Britain, Warongoi Vall., Gazelle Pen., 100 m, V.25.1956, J. L. Gressitt; P 2♂♂, 1♀; BPBM.
- Ragwelellus (N.) indonesicus* Carvalho & Wallerstein, 1979  
Rev. Brasil. Biol. 39(2):475, figs. 7–10; H ♀, Ambon Island, Indonesia, Waai, 12.X.1963, A. M. R. Wegner; P 1♂, 6♀♀; BPBM.
- Ragwelellus (N.) luteonotatus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:46, figs. 33–35; H ♀, New Guinea, NE, Wau, Morobe District, 1200 m, 19.X.61, J. Sedlacek; P 1♂, 3♀♀; BPBM.
- Ragwelellus (N.) magnificus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:47, figs. 36–39; H ♂, New Guinea, NE, Mt. Wilhem, 3000 m, July 4, 1955, J. L. Gressitt; P 5♂♂, 8♀♀; BPBM.
- Ragwelellus (N.) morobensis* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:48, figs. 40–42; H ♂, New Guinea, NE, Morobe District, Ulap, 800–1000 m, IX.68, N. L. H. Krauss; P 8♂♂, 13♀♀; BPBM.
- Ragwelellus (N.) nigrus* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:49, figs. 44–47; H ♂, New Guinea, NE, Busu Riv. E of Leae, 100 m, Sept.13.1955, J. L. Gressitt; P 4♂♂, 5♀♀; BPBM.
- Ragwelellus (N.) similis* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:50, figs. 48–51; H ♂, New Guinea, Wau, Morobe District, Mt. Missim, 1320 m, 2.II.1963, J. Sedlacek; P 4♀♀; BPBM.
- Ragwelellus (R.) szentivanyi* Carvalho & Wallerstein, 1979  
Rev. Brasil. Biol. 39(2):474, fig. 6; H ♀, New Britain, Gazelle Pen., 8–16 Km S of Gaulina, 200–300 m, 29.X.62, J. Sedlacek; BPBM.
- Ragwelellus (N.) wauensis* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:51, figs. 52–55; H ♀, New Guinea, NE Wau, 1200–1600 m, 9.II.68, J. Sedlacek; P 1♂; BPBM.
- Rambea malasica* Carvalho, 1979  
Rec. S. Austr. Mus. 17(30):529, figs. 289–292; H ♂, Peninsular Malaysia, Pahang, Guá Gue Yatin to Terrenggan, 17.XII.1951, L. W. Quate; BPBM.
- Ranzovius fennahi* Carvalho, 1954

- Ann. Mag. Nat. Hist., Ser. 12 4:93, fig. 1A; H ♂, Trinidad, B. W. I., 11.XII.1928, Myers col. (from *Theridion* nest); A ♀, P 8♀♀, 1♂; BMNH.
- Renodaeus gibbicollis* Carvalho & Becker, 1959  
An. Acad. Brasil. Ci. 31(1):116, figs. 2, 7–9; H ♂, Botanical Garden, Georgetown, British Guiana, 26.IX.1918, Harold Morrison Coll.; A ♀; NMNH.
- Resthenia boliviana* Carvalho & Schaffner, 1975  
Rev. Brasil. Biol. 34(4):631, fig. 23 (1974); H ♀, Yanachi, 80 Yungas, Bolivia, M. Cardenas; NMNH.
- Resthenia gaucha* Carvalho, 1953  
Rev. Brasil. Biol. 13(1):79, figs. 1, 6; H ♂, Padill, Dept. Famailla, Tucumán. 16.XII.1951, P. Wygodzinsky leg.; MLP (ex-JCMC).
- Resthenia rubra* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 34(4):632, figs. 24–27 (1974); H ♂, Huascaray, 21.IX.1911, Peru, C. H. Townsend col.; NMNH.
- Resthenia sertaneja* Carvalho, 1975  
An. Acad. Brasil. Ci. 46(2):305, figs. 5–8 (1974); H ♂, Chapada dos Guimarães, Vera, X.1973, M. T., Roppa & Alvarenga; A ♀, P 40♂♂; MN (ex-JCMC).
- Restheniella dysdercoides* Carvalho, 1975  
Rev. Brasil. Biol. 34(4):462, figs. 1–5 (1974); H ♂, Jalisco, Mexico, J. C. M. Carvalho col., III.1971; A ♀; NMNH (ex-JCMC).
- Restheniella lygaeidioides* Carvalho, 1975  
Rev. Brasil. Biol. 34(4):463, fig. 6 (1974); H ♀, Tacamachalco, Puebla, Mexico, 18.VI.1951, F. Pacheco col., NMNH (ex-JCMC).
- Reuteroscopus carmelitanus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):182, figs. 70–74; H ♂, Carmo do Rio Claro, M. G. Brasil, Carvalho & Becker col.; P 11♂♂, 28♀♀; MN.
- Reuteroscopus cisandinus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):184, figs. 75–86; H ♂, Goiás, Brasil, R. Verde, Carvalho; P 5♂♂, 13♀♀; MN.
- Reuteroscopus ecuadorensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):186, figs. 81–84; H ♂, Ecuador, 8 mi of Quevedo, II.3.55, Schlinger & Ross; P 2♂♂, 2♀♀; CAS.
- Reuteroscopus goianus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):188, figs. 85–90; H ♂, Goiás, Brasil, R. Verde, Carvalho; P 1♂, 11♀♀; MN.
- Reuteroscopus guaranianus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):190, figs. 91–95; H ♂, Chapada dos Guimarães, 4.2.1961, Brasil, MT, J. & B. Bechyne; P 1♂, 2♀♀; MN.
- Reuteroscopus matogrossensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):192, figs. 96–99; H ♂, Rosário Oeste, MT, Brasil, XI.63, M. Alvarenga col.; P 2♀♀; MN.
- Reuteroscopus paraensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):194, figs. 100–103; H ♂, Jacareacanga, Pará, Brasil, IX.1970, F.R. Barbosa; P 3♂♂, 3♀♀; MN.
- Reuteroscopus venezuelanus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):196, figs. 104–107; H ♂, Venezuela, Guanare, Est. Portuguesa, IX.10–13.1957, Borys Malkin; NMNH.



*Rewafulvius brachypterus* Carvalho, 1972

Rev. Brasil. Biol. 32(1):53, figs. 1–4; H ♂, Rewa, Fiji, Muir col., IV.1906; NMNH (ex-JCMC).

*Rhasis esavianus* Carvalho, 1953

Rev. Brasil. Biol. 13(2):200, figs. 8–12; H ♂, Viçosa, Minas Gerais, Brasil, JCMC col., 1945; A ♀, P ♂, ♀; MN (ex-JCMC).

*Rhinacloa araguaiana* Carvalho, 1948

Bol. Mus. Nac., Zool. 85:11, figs. 8, 23; H ♂, Aragarças, Goiás, Carvalho col.; A ♀, P 1♂; MN (ex-JCMC).

*Rhinacloa aricana* Carvalho, 1948

Bol. Mus. Nac., Zool. 85:9, figs. 4, 22; H ♂, Arica, Chile, VI.1943, Carvalho col.; A ♀, P 4♂♂, 2♀♀; NMNH (ex-JCMC).

*Rhinacloa bellissima* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(4):596, fig. 3; H ♀, Guadaloupe; P 1♀; MZU.

*Rhinacloa carmelitana* Carvalho, 1948

Bol. Mus. Nac., Zool. 85:8, figs. 5, 17; H ♂, Carmo do Rio Claro, M. Gerais; A ♀, P 17♂♂, 25♀♀; MN (ex-JCMC).

*Rhinacloa castanea* Carvalho, 1948

Bol. Mus. Nac., Zool. 85:10, figs. 9, 21; H ♂, Nova Teutônia, Sta. Catarina, IV.1945, F. Plaumann col.; A 1♀, P 10♂♂, 8♀♀; MN (ex-JCMC).

*Rhinacloa crassitoma* Carvalho, 1984

Bol. Mus. Goeldi, Zool. 1(2):178, figs. 61–65; H ♂, E. do Rio, Brasil, Petrópolis, 58, J.C.M. Carvalho; P 2♂♂, 3♀♀; MN.

*Rhinacloa lepagei* Carvalho, 1954

Rev. Brasil. Ent. 1:115, figs. 1–6; H ♂, São Paulo, Campinas, H. S. Lepage col., 1952; A ♀, P ♂, ♀; MN (ex-JCMC).

*Rhinacloa maiuscula* Carvalho, 1948

Bol. Mus. Nac., Zool. 85:11, figs. 7, 20; H ♂, Nova Teutônia, Sta. Catarina, F. Plaumann col.; A 1♀, P 2♀♀, 11♂♂; MN (ex-JCMC).

*Rhinacloa rubescens* Carvalho, 1968

Proc. Cal. Acad. Sci., Ser. 4 36(7):164, figs. 15–16; H ♂, Galápagos Archipelago, Floreana, Black Beach, 14.II.1964, Usinger; A ♀, P 2♂♂; CAS.

*Rhinocapsidea nordestina* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):253, figs. 7–10; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 960 m., Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa; A ♀, P 2♂♂; MN (ex-JCMC).

*Rotundomiris punctatus* Carvalho, 1981

Rev. Brasil. Biol. 41(3):482, figs. 7–11; H ♂, Papua New Guinea, Mandang District, Finisterre Mts., Damanti, 3550 ft., 2–11.X.64, Stn. no. 46, M. E. Bacchus; BMNH.

*Saileria youngi* Carvalho, 1953

An. Acad. Brasil. Ci. 25(4):574, figs. 1–7; H ♂, Panamá, Prov. Tocumen, 14.IV.1952, F. S. Blanton col., no. 6201; A ♀, P 2♂♂, 5♀♀; NMNH.

*Schaffnerisca loisae* Carvalho, 1975

Rev. Brasil. Biol. 34(1):46, figs. 1–5 (1974); H ♂, Turrialba, Costa Rica, JCMC col., III.1970; NMNH (ex-JCMC).

*Schoutedenomiris acutotylus* Carvalho, 1951

Rev. Zool. Bot. Afr. 45(1–2):101, figs. 4C, D; H ♂, Lulua, Kapanga, X.1932 (F. G. Overlaet col.); A ♀, P 5 specimens; MRAC.

*Sejanus brittoni* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:17, figs. 16–18, 99; H ♂, Queensland, Paluma Dam, 30–31.XII.1964, H. A. Rose; A ♀, P 9♂♂, 4♀♀; QM.

*Sejanus brunneus* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:30, figs. 43–45, 111; H ♂, Tasmania, Lake Dobson, 6.II.1955, T. E. Woodward, on subalpine shrubs; A ♀, P 13♂♂, 11♀♀; QM.

*Sejanus fasciatus* Carvalho, 1982

Austr. Jour. Zool. Suppl. Ser. 86:34, figs. 56–58, 114; H ♀, South Australia, nr. Victory Well, Everard Park Station, 3.XI.1970, G. Gross; A ♂, P 5♂♂, 3♀♀; SAM.

*Sejanus femoralis* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:27, figs. 37–39, 109; H ♂, Queensland, Brisbane, 21.X.1964, H. A. Rose; A ♀, P 2♂♂, 14♀♀; QM.

*Sejanus howardae* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:16, fig. 98; H ♂, North Queensland, McIlwraith Range, NE of Coen, Cape York Peninsula, 29.VI.1976, T. F. Donaldson; P 2♀♀; BPIQ.

*Sejanus intermedius* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:32, figs. 49–52, 112; H ♂, Australian Capital Territory; Mt. Gingera, 4.II.1965, D. H. Colless; A ♀, P 2♂♂, 1♀; ANIC.

*Sejanus lea* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:26, figs. 34–36, 108; H ♂, Queensland, Rockhampton, A. M. Lea, at light; A ♀; ZMUH.

*Sejanus luteoelytratus* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:25, figs. 31–33, 107; H ♂, South Australia, Northern Flinders Ranges, Yudnamutana Gorge, 3.VI.1976, P. B. McQuillan; A ♀; ZMUH.

*Sejanus mcdonaldi* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:21, figs. 22–24, 103; H ♂, Tasmania, Hugel River, Lake St. Clair, 15.II.1955, T. E. Woodward; P 5♂♂; QM.

*Sejanus melaleucaae* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:20, fig. 102; H ♀, Tasmania, Mt. Barrow, 2.II.1973, E. & S. Britton on tea-tree flowers; P 2♀♀; ANIC.

*Sejanus meridionalis* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:24, fig. 106; H ♀, South Australia, Warradale, 1.X.1972, ex-*Acacia*, P. McQuillan; P 8♀♀; SAM.

*Sejanus nevoissi* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:11, figs. 1–3, 94; H ♀, Trymple, 25.XI.1964, Victoria, A. Neboiss; P 2♀♀; NMV.

*Sejanus occidentalis* Carvalho & Gross, 1982

Austr. Jour. Zool. Suppl. Ser. 86:31, figs. 46–48; H ♂, Western Australia, Bunbury, 1–20.X.1958, A. Snell; P 1♂; AM.

*Sejanus palumae* Carvalho & Gross, 1982

- Austr. Jour. Zool. Suppl. Ser. 86:18, figs. 19–21, 100; H ♂, North Queensland, Paluma Dam., 30–31.XII.1964, H. A. Rose; P 8♂♂; QM.
- Sejanus rosei obscurior* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:20; H ♀, North Queensland, Windsor Tableland via Mt. Carbine, 28.XII.1976, R. I. Storey; P 3♀♀; DPIQ.
- Sejanus rosei rosei* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:19, fig. 101; H ♀, Queensland, Ravenshoe, 23.XII.1964, H. A. Rose; P 12♀♀; QM.
- Sejanus ruber* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:12, figs. 4–6, 95; H ♂, North Queensland, Jubilee Rd., 6 Km (4 miles) NE Innisfail, 4.XI.1966, E. Britton; P 1♂; ANIC.
- Sejanus rubricatus* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:13, figs. 7–9, 96; H ♂, North Queensland, Split Rock, 14 Km S Laura, 23–26.VI.1975, G. B. Monteith; A ♀, P 6♂♂, 3♀♀; QM.
- Sejanus tasmaniae* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:23, figs. 28–30, 105; H ♂, L. Dobson, Tasmania, 6.II.1955, T. E. Woodward, on subalpine shrubs; A ♀, P 1♂, 21♀♀; QM.
- Sejanus trivinosus* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:10, fig. 93; H ♀, Victoria, Dartmouth Survey, Six Mile Creek, locality GA, 12.IV.1973; NMV.
- Sejanus uestaustralianus* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:22, figs. 25–27, 104; H ♂, Western Australia, Stirling National Park, 22.IX.1965, E. Britton & Uther Baker; P 2♂♂; ANIC.
- Sejanus unicolor unicolor* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:14, figs. 10–12, 97; H ♂, Australian Capital Territory, Mt. Gingera, 4.II.1965, D. H. Colless; A ♀, P 6♂♂, 2♀♀; QU.
- Sejanus unicolor webbi* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:15, figs. 13–15; H ♂, Queensland, Tibrogargan, 8.X.1960, P. R. Webb; QM.
- Sejanus vividus* Carvalho & Gross, 1982  
Austr. Jour. Zool. Suppl. Ser. 86:33, figs. 53–55, 113; H ♂, Queensland, Brisbane, 22.IX.1964, H. A. Rose; A ♀, P 13♂♂, 32♀♀; QM.
- Semium guatemalanus* Carvalho, 1976  
Rev. Brasil. Biol. 36(3):719, figs. 10–13; H ♂, Guatemala, Nueva Concepcion, 50', VIII. 1963. D. D. Cavagnaro & M. E. Irwin col.; A ♀, P 1♀; CAS.
- Sericophanes dispersus* Carvalho, 1944  
Rev. Brasil. Biol. 4(4):527, figs. 21–24; H ♂, Zapallar, Argentina; A 1♀, P 4♂♂, 2♀♀; MLP (ex-JCMC).
- Sericophanes panamensis* Carvalho, 1955  
Rev. Chil. Ent. 4:224; H ♂, Canal Zone, Panamá, 20.X.939 (J. C. Drake leg.); P 1♂ [misidentified as Knight's *Sericophanes transversus* by Carvalho, 1944, Rev. Brasil. Biol. 4:523, who there illustrated in figs. 13–16 the insect and the male genitalia]; NMNH.
- Sericophanes sulinus* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(3):529, figs. 22–25; H ♂, Republica Argentina, Bariloche, Rio Negro, XI.76, Diego Leonardo Carpintero; P 5♂♂; MACN.
- Sericophanoides punctatus* Carvalho & Rosas, 1965

- Rev. Brasil. Biol. 15(1):54, fig. 14; H ♂, Carmo do Rio Claro, Minas Gerais, I.1960, JCMC col.; A ♀, P 5♂♂; MN (ex-JCMC).
- Sitocoris bybliphilus* China & Carvalho, 1951  
Ann. Mag. Nat. Hist., Ser. 12 4:222, figs. 1–2; H ♂, Cannington, Perth, W. Australia, coletado por F. E. Lloyd, XII.1936; A ♀, P 16; BMNH.
- Sidnia kusaensis* Carvalho, 1956  
Ins. Micronesia 7(1):9, fig. 58g–h; H ♂, Mt. Matante, Kusaie, Feb. 1953, J.F.G. Clarke; A ♀, P 1♀; NMNH.
- Sidnia rotaensis* Carvalho, 1956  
Ins. Micronesia 7(1):100, fig. 58d–f; H ♂, Rota, 23.IV.1946, H. K. Townes; A ♀; NMNH.
- Sinervus amapaensis* Carvalho & Fontes, 1967  
Rev. Brasil. Biol. 27(3):316, figs. 5–10; H ♂, Serra do Navio, 7.VIII.1961, AP, J. & B. Bechyne col.; A ♀, P 12♂♂, 7♀♀; MN.
- Sinervus costalimai* Carvalho, 1945  
Bol. Mus. Nac., Zool. 36:39, fig. 61; H ♂, Viçosa, Minas Gerais, VI.1944 (Carvalho col.); A 1♀, P 3♂♂, 2♀♀; MN.
- Sinervus discopiceus* Carvalho, 1945  
Bol. Mus. Nac., Zool. 36:37, fig. 56; H ♀, Chapada, Mato Grosso; MN (ex-JCMC).
- Sinervus espartacoides* Carvalho & Gomes, 1970  
Rev. Brasil. Biol. 30(3):417, figs. 18–21; H ♂, Chiriaco, Peru, 25.IX.1968, David Ojeda P.; NMNH (ex-JCMC).
- Sinervus hyalipedes* Carvalho, 1945  
Bol. Mus. Nac., Zool. 36:38, fig. 57; H ♂, Viçosa, Minas Gerais, VI.1944 (Carvalho col.); A ♀, P 5♂♂, 7♀♀; MN (ex-JCMC).
- Sinervus sulinus* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):284, figs. 66–69 (1984); H ♀, Santa Catarina, Brasil, Luederwaldt; NM.
- Sixeonotopsis crassicornus* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):15, figs. 10–13 (1973); H ♂, Texas, Gonzales Col., Palmetto St. Pk., 15.IV.1972, J. C. Schaffner; A ♀, P 45♂♂, 128♀♀; NMNH.
- Sixeonotus andinus* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):474, figs. 46–47; H ♂, Barranca, Peru, Lamas col.; A ♀, P 1♂; NMNH (ex-JCMC).
- Sixeonotus brailovskyi* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):284, fig. 70 (1984); H ♀, Harry Brailovski col., Mexico, San Blas, Nayarit, 28.XII.73; P 1♀; UNAM.
- Sixeonotus brasiliensis* Carvalho & Gomes, 1971  
An. Acad. Brasil. Ci. 43(2):475, figs. 48–50; H ♂, Chavantina, M. Bruno, VII.1962, Alvarenga; A ♀, P 15♂♂, 20♀♀; MN (ex-JCMC).
- Sixeonotus manauara* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):285, fig. 71 (1984); H ♂, Manaus, Amazonas, Brasil, Roppa & Oliviera col., VI.1972; MN.
- Sixeonotus minensis* Carvalho, 1985  
Rev. Brasil. Biol. 44(3):286, figs. 72–75 (1984); H ♂, Delfim Moreira, Minas Gerais, Brasil, II.72, O.M. Olivier col., P 4♀♀; MN.



- Slaterocoris reinhardi* Carvalho & Schaffner, 1974  
Rev. Brasil. Biol. 33(Supl.):84, figs. 27–30 (1973); H ♂, 42 miles NW of Mazatlan, Sin., Mex., VIII.15.1965, H. Burke & J. Meyer; A ♀, P 4♂♂, 11♀♀; NMNH.
- Solanocoris semiruber* Carvalho, 1945  
Rev. Brasil. Biol. 5(4):533, figs. 16–19; H ♀, Viçosa, Minas Gerais, VI.1944 (Carvalho col.); A 1♂; MN (ex-JCMC).
- Spanogonicus aricanus* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):198, figs. 108–112; H ♂, Arica, Chile, 6.43. Carvalho col.; P 5♂♂, 7♀♀; CAS.
- Spartacus bolivianus* Carvalho & Gomes, 1971  
Rev. Brasil. Biol. 31(1):66, fig. 2; H ♀, Bolivia, Cochabamba, Germain coll. Noualhier, 1898; P 3♀♀; NMNH (ex-JCMC).
- Spartacus discovittatus* Carvalho, 1945  
Bol. Mus. Nac., Zool. 36:32, fig. 46; H ♂, Viçosa, Minas Gerais, VIII.1943 (Carvalho col.); A ♀, P 11♀♀, 5♂♂; MN (ex-JCMC).
- Spartacus itatiaiensis* Carvalho, 1980  
Rev. Brasil. Biol. 40(3):438, figs. 15–18; H ♂, Brasil, Rio de Janeiro, Parque Itatiaia, Jan, 1978, Carvalho & Schaffner col.; P 54♂♂♀♀; MN (ex-JCMC).
- Spartacus tenuis* Carvalho, 1945  
Bol. Mus. Nac., Zool. 36:34, fig. 50; H ♂, Rio de Janeiro (Jardim Botânico), IV.1944 (H. L. Parker leg.); A 1♀, P 11♀♀; MN (ex-JCMC).
- Stenodema andina* Carvalho, 1975  
Rev. Brasil. Biol. 35(1):128, figs. 18–21, 55 (1974); H ♂, La Angostura, Tucumán, 2000 m, II.1953, JCMC col.; A ♀, P 3♀♀, 6♂♂; MLP (ex-JCMC).
- Stenodema argentina* Carvalho, 1975  
Rev. Brasil. Biol. 35(1):129, figs. 22–25 (1974); H ♂, Catamarca, El Manchado, 15.I.1959, 3000m, R. Golbach col., P 1♂; MLP (ex-JCMC).
- Stenodema brasiliiana* Carvalho, 1980  
Rev. Brasil. Biol. 40(2):304, fig. 20; H ♀, Bela Vista, Mato Grosso, Brasil, VII.78, JCMC col.; MN (ex-JCMC).
- Stenodema guaraniana* Carvalho, 1975  
Rev. Brasil. Biol. 35(1):131, figs. 30–33 (1974); H ♂, Brasilien, Nova Teutonia, 27°11' S, 52°12' W, Fritz Plaumann col.; A ♀, P 4♂♂; MN (ex-JCMC).
- Stenoparedra similis* Carvalho & Dutra, 1961  
Centro Estudos Zool. 12:5, figs. 4, Pr. I D1–2, Pr. II B1–3; H ♂, Chile, nao possui indicacao precisa da localidade; A 1♂, P 1♀, 1♂; NMNH (ex-JCMC).
- Stenopterocorisca viridis* Carvalho, 1981  
Arq. Mus. Nac. R. J. 56:84, figs. 183–186; H ♂, New Guinea, NE, Ambunti, Sepik R., 200 m, 7.V.63, R. Straatman; P 1♂; BPBM.
- Stenotus pusillus* Carvalho & Dutra, 1960  
S. Afr. Anim. Life 7:469, figs. 13, 15; H ♂, Langebert, Trasouwpaas, 900 ft., 4.I.1951, SSAE (no. 111); A ♀, 22♂♂, 17♀♀; LUZI.
- Stenotus rubripes* Carvalho, 1953  
Mem. Inst. Madagascar, Ser. E 3:47, fig. 34A–B; H ♂, vallée de l'Iantara, A. R., 10.XI.1950; MHNP.
- Sthenarus wagneri* Carvalho, 1953  
Beitr. Ent. 5(3–4):335, n.n. for *Capsus bicolor* Mulsant & Rey, 1952, Ann. Soc.

Linn. Lyon 1852:111, n. preocc. by *Capsus bicolor* Lepeletier & Serville, 1925, Encycl. Meth. 10:326.

*Stictolophus amapaensis* Carvalho, 1984

Rev. Brasil. Biol. 44(1):106, figs. 27–30; H ♂, Serra Lombard, Limao, 20.VIII.1961, Brasil, Amapá, J. & B. Bechyne; MN.

*Stictolophus bolivianus* Carvalho & Gomes, 1971

Rev. Brasil. Biol. 31(1):67, figs. 3–4; H ♂, Mapiri, Bolivia; NMNH (ex-JCMC).

*Stictolophus itatiaiensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):286, figs. 76–81 (1984); H ♀, Brasil, Rio de Janeiro, Parna Itatiaia, Jan.1978, Carvalho & Schaffner, MN.

*Stittocapsus mexicanus* Carvalho, 1975

An. Acad. Brasil. Ci. 46(2):323, fig. 1 (1974); H ♀, Mexico, Baja California, Norte 9.5 mi. E of Hamilton Ranch Airfield, 28.IV.1963, H. B. Leech, P. H. Arnaud Jr. collectors; P 2♀♀; CAS.

*Stittocapsus incaicus* Carvalho, 1976

Rev. Brasil. Biol. 36(3):720, fig. 14; H ♀, 40 mi. E of Abancay, Peru, 5.III.51, Ross & Michelbacher collectors; P 2♀♀; CAS.

*Surinamella doesburgi* Carvalho & Rosa, 1962

Rev. Brasil. Biol. 22(4):431, figs. 6–10; H ♂, Paramaribo, Suriname, coligido por P. H. van Doesburg Jr., 12.V.1962; A ♀, P 4♂♂, 4♀♀; NMNH (ex-JCMC).

*Sysinas boliviensis* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):476, figs. 51–54; H ♂, Tacú Buenavista Ichilo, Bolivia, III.1951, Prosen; A ♀, P 4♂♂, 1♀; NMNH (ex-JCMC).

*Sysinas panamensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):290, figs. 95–98 (1984); H ♂, Panama, C.Z., Fortuna, V.70, H. Wolda; P 1♂; NMNH.

*Taedia angrensis* Carvalho, 1975

Rev. Brasil. Biol. 35(2):186, figs. 49–52; H ♂, Angra dos Reis, Jussaral, Lauro Travassos, Jose Oiticica Filho & J. Lins de Almeida col.; MN (ex-JCMC).

*Taedia bahiana* Carvalho, 1975

Rev. Brasil. Biol. 35(2):187, figs. 53–56; H ♂, Estrada Rio-Bahia, Km 965, Motel da Divisa, 900 m, Encruzilhada, Bahia, Brasil, XI.1972, Seabra & Roppa col.; A ♀, P 3♀♀, 10♂♂; MN (ex-JCMC).

*Taedia batesi* Carvalho, 1980

Rev. Brasil. Biol. 40(2):315, figs. 18–21; H ♀, Fonte Boa, Amazonas, IX.75, F. M. Oliveira col.; P 1♂, 1♀; MN (ex-JCMC).

*Taedia cabocla* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):256, figs. 9–12; H ♂, Goiás, Brasil, Aragarças, 1945, Carvalho col., A ♀, P 10♂♂, 3♀♀; MN (ex-JCMC).

*Taedia cajabiana* Carvalho, 1976

Rev. Brasil. Biol. 36(4):769, figs. 14–18; H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, Alvarenga & Roppa col., IX.1974 e X.1975; A ♀, P 14♂♂, 6♀♀; MN (ex-JCMC).

[*Taedia cipoa*—see *Poegas cipoa*]

*Taedia coimbrai* Carvalho, 1975

Rev. Brasil. Biol. 35(3):505, figs. 18–22; H ♂, Sinop, Teles Pires, Mato Grosso, IX.1974, Alvarenga & Roppa col.; A ♀, P 10♂♂, 5♀♀; MN (ex-JCMC).

*Taedia compacta* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):257, figs. 13–16; H ♂, Floresta da Tijuca, D. Federal, Brasil, 8.II.1952, C. A. Campos Seabra; A ♀, P 2♀♀; MN (ex-JCMC).

*Taedia compactina* Carvalho, 1975

Rev. Brasil. Biol. 35(2):189, figs. 57–60; H ♂, Vera, Mato Grosso, Brasil, Alvarenga & Roppa col.; A ♀, P 8♀♀; MN (ex-JCMC).

*Taedia compactoides* Carvalho, 1975

Rev. Brasil. Biol. 35(2):192, figs. 61–62; H ♂, Sinop, R Teles Pires, MT., Brasil, Alvarenga & Roppa col.; A ♀, P 96♂♂♀♀; MN (ex-JCMC).

*Taedia cylapoides* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):259, figs. 17–20; H ♂, Bolivien, Prov. Sara, col. Steinbach S., Mus. Zool. Helsinki; A♀, P 2♂♂, 2♀♀; MZU.

*Taedia diamantina* Carvalho, 1984

Rev. Brasil. Biol. 44(1):108, figs. 31–34; H ♂, Diamantino, Faz. S. Joao, Mato Grosso, Brasil, Km 20, Br 163, Roppa col.; P 1♀; MN (ex-JCMC).

*Taedia distantina* Carvalho, 1954

An. Acad. Brasil. Ci. 26(3–4):426, n.n. for *Taedia bimaculata* Distant, 1883, Biol. Centr.-Amer., Rhyn., Het. 1:262, n. preocc. by *Taedia bimaculata* (Fabricius, 1803) (as *Capsus*), Syst. Rhyng., p. 243.

*Taedia elongata* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):261, figs. 21–24; H ♀, Bolivia, Yunga de la Paz, 1000 m, D. Garlepp S. col.; A ♂, P 2♂♂, 1♀; NMNH (ex-JCMC).

*Taedia incaica* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):264, figs. 32–35; H ♂, Trinidad, Bolivia, 1922–23, M. S. Pennington; A ♀, P 1♂; NMNH (ex-JCMC).

*Taedia manauara* Carvalho, 1983

Acta Amazon. 13(1):188, figs. 19–22; H ♂, Brasil, Reserva Ducke, Manaus, Amazonas, L. P. Albuquerque & A. Faustino, 29.IV.1968; P 1♂, 1♀; INPA.

*Taedia mexicana* Carvalho, 1975

Rev. Brasil. Biol. 35(2):193, figs. 71–74; H ♀, C. D. Obregon, Sonora, Mexico, 29.IX.1955, algodón, col. F. Pacheco; A ♂, P 1♀; NMNH (ex-JCMC).

*Taedia missionera* Carvalho, 1975

Rev. Brasil. Biol. 35(2):195, figs. 75–78; H ♂, Misiones, Argentina, Dep. Concepcion, Santa Maria, M. J. Viana col.; A ♀; MLP (ex-JCMC).

*Taedia multicolor* Carvalho, 1975

Rev. Brasil. Biol. 35(2):196, figs. 79–83; H ♂, Mexico, Puebla, 6 mi. SW Tehuacan, July 8–10.1973, Mastro & Schaffner; A ♀, P 14♂♂, 18♀♀; NMNH.

*Taedia pacifica* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):272, figs. 55–58; H ♂, Equador, Guayaquil, 43, Carvalho col.; A ♀, P 8♂♂, 11♀♀; NMNH (ex-JCMC).

*Taedia rondonia* Carvalho, 1983

Acta Amazon. 13(1):186, figs. 15–18; H ♂, Brasil, Território Federal de Rondônia (atual Estado de Rondônia), 11.09.63, col. Eduardo, 2797; INPA.

*Taedia schaffneri* Carvalho, 1975

Rev. Brasil. Biol. 35(2):199, figs. 84–88; H ♂, Mexico, Puebla, 4 mi. W Acatepec, 26.VII.1973, Mastro & Schaffner; A ♀, P 46♂♂, 45♀♀; NMNH.

*Taedia scutellata* Carvalho & Wallerstein, 1978

Rev. Brasil. Biol. 38(2):255, figs. 16–19; H ♂, Pirapora, Minas Gerais, Brasil, XI.1976, Seabra, Roppa & Monne; A ♀, P 26♂♂, 10♀♀; MN (ex-JCMC).

[*Taedia serrana*—see *Poea serrana*]*Taedia signata* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):277, figs. 66–69; H ♂, Minas Gerais, C. R. Claro, Carvalho col.; A ♀, P 3♂♂, 25♀♀; MN (ex-JCMC).

*Taedia similaris* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):279, fig. 70; H ♀, Brasilien, Nova Teutônia, 27°11' B, 52°23' L, X-1944, Fritz Plaumann; P 1♀; MN (ex-JCMC).

*Taedia sulina* Carvalho, 1959

An. Acad. Brasil. Ci. 26(3–4):426, n.n. for *Calocoris bimaculatus* Berg, 1892, An. Soc. Ci. Argent. 34:91, n. preocc. by *Calocoris bimaculatus* (Fabricius), 1803, Syst. Rhyng., p. 243 (as *Capsus*).

*Taedia sulina* var. *fasciata* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(1):285.

*Taedia tehuacana* Carvalho, 1974

Rev. Brasil. Biol. 35(2):202, figs. 93–96; H ♂, Mexico, Puebla, 6 mi. SW Tehuacan, 8–10.VII.1973, Mastro & Schaffner; A ♀, P 47♂♂♀; NMNH.

*Taedia tibiannulata* Carvalho, 1975

Rev. Brasil. Biol. 35(3):507, figs. 23–28; H ♂, estrada Rio-Bahia, Km 965, Motel da Divisa, 960m, Encruzilhada, Brasil, XI.1972, Seabra & Roppa col.; A ♀, P 1♂; MN (ex-JCMC).

*Taedia tucuruensis* Carvalho, 1981

Rev. Brasil. Biol. 41(1):13, fig. 5; H ♂, Tucuruí, Pará, Brasil, M. Alvarenga, I.79; P 2; MN (ex-JCMC).

*Taedia xinguana* Carvalho, 1975

Rev. Brasil. Biol. 35(2):204, figs. 97–100; H ♀ Xingu, Mato Grosso, IX.1961, Alvarenga col.; A ♂, P 4♀♀; MN (ex-JCMC).

*Tamoicoris compactus* Carvalho, 1984

Rev. Brasil. Biol. 44(1):54, figs. 21–24; H ♀, Nova Teutônia, Santa Catarina, Brasil, 27°11' N [lapsus for S], 52°23' W, October 1970, Fritz Plaumann; P 1♂, 1♀; MN.

*Tapuruyunus acangatus* Carvalho, 1946

Bol. Mus. Nac., Zool. 59:4, figs. 2, 5–12; H ♂, Viçosa, M. Gerais, X.1945, Flavio Couto col., proximo a piscina, no fundo das tres casas; MN (ex-JCMC).

*Taricoris gressitti* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:85, figs. 187–192; H ♂, New Guinea, SE, above Tigobi near Tari, 1700 m, 1.VI.1966, J. L. Gressitt; P 1♂; BPBM.

*Taricoris wauensis* Carvalho, 1981

Arq. Mus. Nac. R. J. 56:86, figs. 193–196; H ♂, New Guinea, NE, Wau, Big Wau Ck., 1200 m, IX.1965, P. Shanahan; BPBM.

*Tenthecoris bahiensis* Carvalho, 1985

Rev. Brasil. Biol. 44(3):287, figs. 82–85 (1984); H ♂, Estr. Rio Bahia, km 965, Motel de Divisa, 960 m, Encruzilhada, Bahia, Brasil, XI.1972, Sebra & Roppa; MN.



*Tenthecoris boliviensis* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):477, fig. 55; H ♀, Bolivia, Maipiri; P 1♀; NMNH (ex-JCMC).

*Tenthecoris carioca* Carvalho & Gomes, 1971

An. Acad. Brasil. Ci. 43(2):477, fig. 56; H ♀, Rio de Janeiro, Paineiras, 3.IV.1957, Carvalho et Becker colls.; P 1♀; MN (ex-JCMC).

*Tenthecoris costaricensis* Carvalho, 1954

Jour. Kans. Ent. Soc. 26:102, fig. 2B, E; H ♂, Costa Rica, intercepted at San Francisco, California (on orchids), cat. no. 61990; NMNH.

*Tenthecoris ecuadorensis* Carvalho, 1954

Jour. Kans. Ent. Soc. 27(3):104, fig. 2F-J; H ♂, Ecuador, 12.V.1947, on *Cattleya* leaf, cat. no. 61991; A ♀, P 1♀, 4 nymphs; NMNH.

*Tenthecoris figueiredoi* Carvalho, 1950

An. Acad. Brasil. Ci. 22(1):19, figs. 10-14; H ♂, Santos, São Paulo, Eduardo Figueiredo Junior col., II.1949; A ♀, P ♂, ♀; MN (ex-JCMC).

*Tenthecoris hsiaoi* Carvalho, 1948

Rev. Ent. R. J. 19(1-2):279, figs. 1-3; H ♀, São Paulo, Brasil, O. Monte col.; A ♂, P 12♂, 13♀♀; MN (ex-JCMC).

*Tenthecoris iheringi* Carvalho, 1985

Rev. Brasil. Biol. 44(3):288, figs. 86-89 (1984); H ♀, Piracununga, São Paulo, Brasil, 19.IV.1938, Aristoteles Silva col.; P 1♂; MN.

*Tenthecoris nanus* Carvalho, 1948

Rev. Ent. R. J. 19(1-2):180, figs. 4-6; H ♂ Viçosa, Minas Gerais, Brasil, VIII.1943, Carvalho col.; A ♀, P 20♀♀, 16♂♂; MN (ex-JCMC).

*Tenthecoris rubrus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):289, figs. 90-93 (1984); H ♂, El Salvador, 3m of La Libertad, 30 Aug.1972, G.F. & S. Hevel; P 2♂, 2♀♀; NMNH.

*Teratofulvius punctatus* Carvalho & Lorenzato, 1978

Rev. Brasil. Biol. 38(1):47, figs. 83-87; H ♂, New Guinea. (Neth.), Wisselmeren, 1700 m, Wagheto Tigi L., 17.VIII.1955, J. L. Gressitt; A ♀, P 1♂, 1♀; BPBM.

*Termatophyllella fulvioides* Carvalho, 1955

Proc. U.S. Nat. Mus. 104(3348):644, fig. 123c, f, plate 31B; H ♂, San Luis Potosi, Mexico, "Bt. Tex. 69391", on orchids, 7.III.1950, 61947; A ♀; NMNH.

*Termatophyllella ocellata* Carvalho, 1955

Proc. U.S. Nat. Mus. 104(3348):646, plate 31C; H ♀, San Pedro de Montes de Oca, Costa Rica, on *Vernonia brachiata*, C. H. Ballou, 15.X.1936, 61948; NMNH.

*Termatophyllella opaca* Carvalho, 1955

Proc. U.S. Nat. Mus. 104(3348):648, plate 31A; H ♀, Georgetown, British Guiana, 26.IX.1918, "H. Morrison col.", Botanic Garden (on *Sarcocephalus esculentus*); NMNH.

*Termatophylloides pilosulus* Carvalho, 1955

Proc. U.S. Nat. Mus. 104(3348):643, fig. 123a, d, g; H ♀, Tamazunchale, San Luis Potosi, Mexico, on orchids, 30.XII.1948, Ins. Lary coll., Laredo, Tex., 49529, 61946; P 1♀; NMNH.

*Tibiocoris tibialis* Carvalho & Gomes, 1970

Rev. Brasil. Biol. 30(3):412, figs. 1-4; H ♂, Amazons florden, Mus. Moscow; A ♀, P 2♂, 1♀; MZU.

*Totolapanus pseudoxenoides* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 35(2):353, figs. 7–15; H ♂, Mexico, Oaxaca, 16 mi. nw Totolapan, 12.VII.1974, Clark, Murray, Ashe, Schaffner; P 2♂♂; NMNH.

*Trigonotyliscus brasiliensis* Carvalho, 1975

Rev. Brasil. Biol. 35(1):138, figs. 46, 56 (1974); H ♀, Represa Rio Grande, Jacarepagua, Rio de Janeiro, Brasil, F. M. Oliveira col.; P 1♀; MN (ex-JCMC).

*Trigonotylus americanus* Carvalho, 1957

Arq. Mus. Nac. R. J. 43:126, figs. 1gs, 1, r, s1–2; H ♂, Lake Point, Utah, 18.V.1946, C. F. Knowlton coll. (inj. Rye); P 64 specimens; NMNH.

*Trigonotylus californicus* Carvalho, 1955

Arq. Mus. Nac. R. J. 43:128, figs. 31, r, s1–4; H ♂, Bard., Cal., 1.VI, Oman, 1935; P ♂, ♀; NMNH.

*Trigonotylus montanus* Carvalho, 1957

Arq. Mus. Nac. R. J. 43:137, figs. 101, r–s; H ♂, Chambers Lake, Laramie Co., Colorado, D. F. Baker coll., VIII.1896 (on grass and carrots meadow); P 107 specimens; NMNH.

*Trigonotylus saileri* Carvalho, 1957

Arq. Mus. Nac. R. J. 43:145, figs. 161, r–s; H ♂, Crisfield, Maryland, b.29/7.5/1932, F. C. Bishop col. 1 (mosquito trap); P 50♂♂♀; NMNH.

*Trigonotylus slateri* Carvalho, 1957

Arq. Mus. Nac. R. J. 43:147, figs. 171, r–s; H ♂, Pine Springs, Texas, 10.I.1950, J. C. Elkins coll.; NMNH.

*Trigonotylus usingeri* Carvalho, 1952

Bol. Mus. Nac., Zool. 111:1, figs. 1–4; H ♂, Humuula, Hawaii, 1 mile N, 30.VII.1935, R. L. Usinger coll.; A ♀, P 3♂♂, 4♀♀; CAS.

*Trilaccus annulipes* Carvalho, 1953

Entomologist 86:88, fig. 6; H ♀, Queensland, F. P. Dodd, Brit. Mus. 1907.54, Kurando, May 04, F. P. Dodd; P 8♀♀; BMNH.

*Tropidosteptes chapingoensis* Carvalho & Rosas, 1965

Rev. Brasil. Biol. 25(2):187, figs. 1–6; H ♂, Chapingo, Mexico, 9.VII.1964, Hosp. *Fraxinus uhdei*; A ♀, P 5♂♂, 44♀♀; NMNH (ex-JCMC).

*Trygo bipunctatus* Carvalho, 1985

Rev. Brasil. Biol. 44(3):375, fig. 38 (1984); H ♂, Panamá, CZ, lt. Fortuna, V.76, H. Wolda col.; NMNH.

*Tucuruiella amazonensis* Carvalho, 1982

Acta Amazon. 12(1):181, figs. 1–3; H ♂, Estirão do Equador, AM, Brasil, X.79, Alvarenga; P 1♂; MN.

*Tucuruiella matogrossensis* Carvalho, 1982

Acta Amazon. 12(1):182, figs. 4–6; H ♂, Vera, Mato Grosso, Brasil, Alvarenga & Roppa; MN.

*Tucuruiella tapajoensis* Carvalho, 1982

Acta Amazon. 12(1):183, figs. 7–12; H ♂, Sinop, 12°13' s, 55°37' W, Br 163, Km 500–600, Mato Grosso, Brasil, 360 m, X.74, Alvarenga & Roppa; P 5♂♂, 3♀♀; MN.

*Tupimiris scutellatus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):36, figs. 9–12 (1973); H ♂, Nova Teutônia, Santa

- Catarina, Brasil, 27°11' N [lapsus for S], 52°23' W, XII.1970, Fritz Plaumann; P 5♂♂; MN (ex-JCMC).
- Tupiniquinus squamosus* Carvalho, 1984  
Rev. Brasil. Biol. 44(1):56, figs. 25–29; H ♂, Km 47, Estrada Rio-Sao Paulo, 5.12.1945, Wygodzinsky col.; MN (ex-JCMC).
- Tuponia mascarenensis* Carvalho, 1953  
Mem. Inst. Sci. Madagascar, Ser. E 3:50, figs. 2, 3C–D; H ♀, Bas-Sambirano, IX.1949; A ♂, P 2♀♀; NHNP.
- Tuxenella araucana* Carvalho & Dutra, 1959  
Arq. Mus. Nac. R. J. 49:145, figs. Pr. 1, Pr. 2b, Pr. 3b; H ♂, 15 milhas de Los Vilos, Coquimbo, XII.1950, Rosas & Michelbacher col.; CAS.
- Tuxenella atacamana* Carvalho & Dutra, 1959  
Arq. Mus. Nac. R. J. 49:148, figs. 4, Pr. 1, Pr. 2h, Pr. 3h; H ♂, A. Amarga, Atacama, Chile, 9/57, Kuschel col.; A ♀, P 3♂♂; NMNH (ex-JCMC).
- Tuxenella similis* Carvalho & Dutra, 1959  
Arq. Mus. Nac. R. J. 49:147, figs. Pr. 1, Pr. 2; H ♂, El Tofo, Coquimbo, Chile, Kuschel col., X.1952; NMNH (ex-JCMC).
- Tuxenella tibionigra* Carvalho & Dutra, 1959  
Arq. Mus. Nac. R. J. 49:146, figs. Pr. 1, Pr. 2a, Pr. 3a; H ♂, Valparaiso, Chile, XI.1952, Kuschel col.; P 4♂♂; NMNH (ex-JCMC).
- Tuxenella tibiopallida* Carvalho & Dutra, 1959  
Arq. Mus. Nac. R. J. 49:146, figs. 3, Pr. 1, Pr. 2d, Pr. 3d; H ♀, 22 milhas de Talca, Rosas & Michelbacher col., XII.1950; P 4♂♂; CAS.
- Tytthus amazonicus* Carvalho, 1983  
Acta Amazon. 13(1):191, figs. 23–26; H ♂, Brasil, AM (Amazonas), 18.VI.1976, I. S. Gorayeb; P 7♂♂, 7♀♀; INPA.
- Tytthus columbiensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):202, fig. 118; H ♂, Palmira (V.), Colombia, IX.26.58, G. Bravo; NMNH.
- Tytthus hondurensis* Carvalho, 1984  
Bol. Mus. Goeldi, Zool. 1(2):203, fig. 119; H ♂, Lancetilla, Honduras, Aug., Stadelmann; NMNH.
- Tytthus juturnaiba* Carvalho & Wallerstein, 1978  
Rev. Brasil. Biol. 38(2):256, figs. 20–25; H ♂, Lagoa Juturnaiba, Araruama, Estado do Rio de Janeiro, XI.1976, L. Alvarenga; A ♀; MN (ex-JCMC).
- Tytthus montanus* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi 11(2):32, fig. 7B–D, F; H ♂, Drummond, Montana, Oman col.; VII.1953; NMNH.
- Tytthus panamensis* Carvalho & Southwood, 1955  
Bol. Mus. Goeldi, 11(2):32, fig. 7E, G; H ♂, Corozal, C. Z. Panama, A. Busck col. (at light); P 3♂♂; NMNH.
- Ueleana longicuneata* Carvalho, 1951  
Rev. Zool. Bot. Afr. 45(1–2):103, fig. 1; H ♀, Haut Uele, Yebo Moto, IX.1926 (L. Burgeon coll.); MRAC.
- Umboiella antennata* Carvalho, 1981  
Rev. Brasil. Biol. 41(3):461, fig. 1; H ♂, NE, New Guinea, Umboi I., 1 Km N Awelkon, 600 m, 21–28.II.1967, G. A. Samuelson; BPBM.

*Urubumiris maranhensis* Carvalho, 1976

Rev. Brasil. Biol. 35(4):684, figs. 1–6 (1975); H ♂, Ilha das Balsas, Maranhão, Brasil, VIII.1972, JCMC col.; MN (ex-JCMC).

*Urubumiris tapajoensis* Carvalho, 1976

Rev. Brasil. Biol. 35(4):685, figs. 7–11 (1975); H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; MN (ex-JCMC).

*Urucuiana tuberculata* Carvalho & Rosas, 1965

Rev. Brasil. Biol. 25(2):208, figs. 1–4; H ♂, Suriname, Kabeilig, V.1961, P. H. van Doesburg col.; NMNH (ex-JCMC).

*Vannius oculatus* Carvalho, 1955

Proc. U.S. Nat. Mus. 103(3337):628, fig. 74d; H ♀, USNM 61942, Costa Rica (on bananas), intercepted at New York, May 11, 1936; NMNH.

*Veramiris minutus* Carvalho, 1975

Rev. Brasil. Biol. 34(4):465, figs. 8–11 (1974); H ♂, Vera, Mato Grosso, Brasil, M. Alvarenga & Roppa col.; MN (ex-JCMC).

*Waterhouseana illustris* Carvalho, 1973

Rev. Brasil. Biol. 33(4):5, figs. 8–9; H ♀, on tree trunk, 3500 feet, Bulolo, Territory of New Guinea, XII.1967, B. Lowery; ANIC.

*Woodwardiola monteithi* Carvalho, 1973

Rev. Brasil. Biol. 33(4):6, figs. 10–15; H ♂, F. W. Lake, 10 m N of Rocky R., via Goen, N. Qld., 17.XII.1964, G. Monteith; A ♀, P 5♂♂, 6♀♀; QM.

*Xoklengana sulina* Carvalho & Rosas, 1965

An. Acad. Brasil. Ci. 37(1):85, fig. 3; H ♀, Brasilien, Nova Teutônia, 27°11' B, 52°23' L, Fritz Plaumann col., 5.VIII.1938; MN (ex-JCMC).

*Yebonia hyaloscutellata* Carvalho, 1951

Rev. Zool. Bot. Afr. 45(1–2):111, fig. 6B–E; H ♂, Haut Uele, Moto Yebo, XI.1925 (L. Burgeon coll.); MRAC.

*Zacynthus costaricensis* Carvalho & Ferreira, 1974

Rev. Brasil. Biol. 33(Supl.):184, figs. 1–3 (1973); H ♂, Costa Rica, Eben e Von Limon bei, Las Mercedes, Farm Hamburg am Reventazon, 15.IV.1923, 1030 m U, M. 12–13 Km von Atlantik, F. Nevermann leg.; A ♀; NMNH (ex-JCMC).

*Zanchisme inermis* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):57, figs. 6–10 (1973); H ♂, La Ventosa, 72 mi. E., Oax., Mex., 21.VII.1963, J. Doyen collector; CAS.

*Zanchisme mexicanus* Carvalho & Schaffner, 1974

Rev. Brasil. Biol. 33(Supl.):55, figs. 1–5 (1973); H ♂, Mexico, Oaxaca, 11.6 miles West of Jalapa del Marques, 12.VII.1971, taken at light, Clark, Murray, Hart, Schaffner; A ♀; NMNH.

*Zanchismella bispinosa* Carvalho & Wallerstein, 1976

Rev. Brasil. Biol. 35(4):632, figs. 16–23, 29–31 (1975); H ♂, Sinop, Rio Teles Pires, Mato Grosso, Brasil, IX.1974, Alvarenga & Roppa col.; MN (ex-JCMC).

*Zanchismisca guanabarina* Carvalho & Wallerstein, 1976

Rev. Brasil. Biol. 35(4):634, figs. 24–28, 39–41 (1975); H ♂, Base aerea de Santa Cruz, Estado do Rio de Janeiro, ESAG col., XII.1974; MN (ex-JCMC).

*Zanchius carolinensis* Carvalho, 1956

Ins. Micronesia 7(1):66, figs. 38b, 39a–b, 41e–f; H ♂, Mt. Iron, Fefan I., Truk, 31.I.1953, J. L. Gressitt; A ♀, P 23♂♂, 10♀♀; NMNH.



*Zapotecoris elongatus* Carvalho & Schaffner, 1975

Rev. Brasil. Biol. 34(3):299, figs. 6-9 (1974); H ♂, Mexico, Oaxaca, 2.7 mi. NW El Cameron, 13.VII.1971, taken at light, Clark, Murray, Hart, Schaffner; A ♀; NMNH.

*Zelotocoris vicosensis* Carvalho & Ferreira, 1981

Rev. Brasil. Biol. 41(1):9, figs. 1-4; H ♂, Viçosa, Minas Gerais., Brasil, 6.XII.78, Ferreira & Rossi; MN (ex-JCMC).

*Zikaniola elegans* Carvalho, 1946

Bol. Mus. Nac., Zool. 61:5, figs. 9-15, 18; H ♂, Rezende, 16.X.1941, Holmes col.; A ♀, P 4♂♂, 8♀♀; MN (ex-JCMC).

## Family Saldidae

*Pentacora angusta* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):473; H ♂, in the coast of Rio Negro, Argentina; A ♀, P 1♀; DC.

*Saldula brasiliensis* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):477; H ♀, Minas Gerais, Brasil, C. R. Claro; P 4; MN.

*Saldula differata* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):478; H ♀, Rio Negro, Argentina; DC.

*Saldula doeringi* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):475; H ♀, Rio Colorado, Lynch & Doering; MLP.

*Saldula lynchi* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):476; H ♀, Chasmcomus, collected by Lynch & Doering; MLP.

*Saldula penningtoni* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):479; H ♂, Buenos Aires, Nov. 23, 1938, collected near a shallow pond and along a small stream by C. J. Drake; A ♀, P "many"; DC.

*Saldula sola* Drake & Carvalho, 1948

Rev. Ent. R. J. 19(3):476; H ♀, Rio Negro, Argentina; A ♂; DC.

## Family Tingidae

*Gargaphia arizonica* Drake & Carvalho, 1944

Bull. Brook. Ent. Soc. 29(1):43; H ♂, Huachuca Mts., Aug., 1934, C. J. Drake; A ♀, P several; DC.

*Gargaphia balli* Drake & Carvalho, 1944

Bull. Brook. Ent. Soc. 29(1):42; H ♂, Naco, Ariz., Sept. 12, 1935, E. D. Ball; A ♀, P 5; DC.

*Gargaphia tuthilli* Drake & Carvalho, 1944

Bull. Brook. Ent. Soc. 29(1):42; H ♂, Mesa Verde, Colo., July 3, 1937, L. D. Tuthill; P 2♂♂; DC.

*Teleonemia guyanensis* Drake & Carvalho, 1944

Bull. Brook. Ent. Soc. 29(1):41; H ♀, Mallali, British Guiana, H. S. Parish; DC.

## Family Veliidae

*Microvelia parana* Drake & Carvalho, 1954

Proc. Biol. Soc. Wash. 67:223; H ♂, Belém, Pará, 9.X.1938, Hambleton & Sauer; A ♀, P 7 specimens; DC.

*Microvelia quieta* Drake & Carvalho, 1954

Proc. Biol. Soc. Wash. 67:224, fig. 1; H ♂, Carmo do Rio Claro, Minas Gerais, Brasil; A ♀, P 11 specimens; MN.

*Rhagovelia macta* Drake & Carvalho, 1955

An. Acad. Brasil. Ci. 27(3):361; H ♂, Carmo do Rio Claro, Minas Gerais, Brasil, Jose C. M. Carvalho; A ♀, P 24 specimens; MN.

*Rhagovelia pacayana* Drake & Carvalho, 1953

An. Acad. Brasil. Ci. 27(3):363; H ♂, Pacaya, Cuchara River, Peru, VIII.1954; A ♀, P 22 specimens; DC.

## LIST OF ABBREVIATIONS FOR INSTITUTIONS CONTAINING HOLOTYPE

AM—The Australian Museum, Sydney

AMNH—American Museum of Natural History, New York

ANIC—Australian National Insect Collection, Canberra

BMNH—British Museum of Natural History, London

BPBM—Bernice P. Bishop Museum, Honolulu

BPIQ—Department of Primary Industries of Queensland, Brisbane

CAS—California Academy of Sciences, San Francisco

CIE—Colecion de Investigaciones Entomologicas, Universidade de Chile, Santiago

CM—Carnegie Museum, Pittsburgh

CP—Colecion L. E. Pena, Santiago

DAT—Tasmanian Department of Agricultura, Hobart

DC—Drake Collection, now in the National Museum of Natural History, Washington, D.C.

ECKU—Entomological Collection, Kyushu University, Fukuoka

IEA—Instituto de Experimentação Agrícola, Universidade Federal Rural do Estado do Rio de Janeiro

IFAN—Institut Francaise de L'Afrique Noire, Dakar

IML—Instituto Miguell Lillo, Tucumán

INPA—Instituto Nacional de Pesquisas Amazonicas, Manaus

IOC—Instituto Oswaldo Cruz, Rio de Janeiro

JCMC—Coleção Jose Candido de Melo Carvalho, Rio de Janeiro

LUZI—Lund Universitets Zoologiska Institut, Lund

MACN—Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires

MCHN—Museo Chileno de Historia Natural, Santiago

MEFLG—Museo Entomologica Francisco Luiz Gallego

MHNP—Museum d'Histoire Naturelle, Paris

MLP—Museo de La Plata, La Plata

MN—Museu Nacional, Rio de Janeiro

MRAC—Musée Royal de L'Afrique Centrale, Tervuren

MRS—Museu Riograndense de Ciencias Naturais, Porto Alegre

MZU—Museum Zoologicum Universitatis, Helsinki

NM—Naturhistorisches Museum, Wien

NMNH—National Museum of Natural History, Washington, D.C.

NMV—National Museum of Victoria, Melbourne

NR—Naturhistoriska Riksmuseet, Stockholm

- QM—Queensland Museum, Brisbane  
 QU—Collection of the University of Queensland, Brisbane  
 SAM—South Australian Museum, Adelaide  
 SCUK—Snow Collection, University of Kansas, Lawrence  
 UC—Usinger Collection, California Academy of Sciences, San Francisco  
 UNAM—Universidad Nacional Autonoma, Mexico  
 UNMZ—University of Michigan Museum of Zoology, Ann Arbor  
 UZM—Universitets Zoologiske Museet, Kobenhavn  
 WDA—Western Australian Museum Department of Agriculture  
 ZM—Zoologisches Museum (Museum für Naturkunde an der Humboldt-Universität zu Berlin), Berlin

## LIST OF JOURNALS CITED BY ABBREVIATIONS

- Acta Amazon.—Acta Amazonica  
 Acta Soc. Sci. Fenn.—Acta Societatis Scientiarum Fennicae  
 Amaz.—Amazoniana, Plon  
 Amer. Mus. Nov.—American Museum Novitates  
 An. Acad. Brasil. Ci.—Anais da Academia Brasileira de Ciencias  
 An. Soc. Sci. Argent.—Anales de la Sociedad Científica Argentina  
 Ann. Mag. Nat. Hist.—Annals and Magazine of Natural History  
 Ann. Mus. Nat. Hung.—Annales Musei Nationalis Hungarici  
 Ann. Nat. Hofsm. Wien—Annalen des Kaiserlich-königlichen Naturhistorischen Hofsmuseum, Wien  
 Ann. Soc. Linn. Lyon—Annales de la Société Linéenne de Lyon  
 Arq. Mus. Nac. R. J.—Arquivos de Museu Nacional, Rio de Janeiro  
 Austr. Jour. Zool. Suppl. Ser.—Australian Journal of Zoology Supplementary Series  
 Beitr. Ent.—Beiträge zur Entomologie  
 Bernst. befind. organ. reste vorw.—Die im Bernstein befindlichen organischen Reste der Vorwelt  
 Biol. Centr.-Amer., Rhynch. Het.—Biologia Centrali-Americana, Insecta, Rhynchota Heteroptera  
 Bol. Mus. Goeldi—Boletim do Museu Paraense Emilio Goeldi  
 Bol. Mus. Goeldi, Zool.—Boletim do Museu Paraense Emilio Goeldi, Zoologia  
 Bol. Mus. Nac., Zool.—Boletim do Museu Nacional, Zoologia, Rio de Janeiro  
 Bull. Brook. Ent. Soc.—Bulletin of the Brooklyn Entomological Society  
 Bull. Ent. Res.—Bulletin of Entomological Research  
 Bull. Soc. Nat. Mosc.—Bulletin de la Société Impériale des Naturalistes de Moscou  
 Centro Estudo Zool.—Centro de Estudos Zoológicos, Universidade do Brasil  
 Encyc. Meth.—Encyclopédie Méthodique  
 Ent. Gen.—Entomologia Generalis  
 Ent. Medd.—Entomologiske Meddelelser  
 Ent. News—Entomological News  
 Ent. Syst.—Entomologia Systematica Emendata et Aucta  
 Fauna And.—Fauna Andalusia  
 Florida Ent.—Florida Entomologist  
 Fol. Ent. Mex.—Folia Entomologica Mexicana

- Hem. Arg.—Hemiptera Argentina, Enumeravit Speciesque Novas  
 Hist. Fis. Pol. Chile—*In* Gay, editor, Historia Fisica y Politica de Chile  
 Ins. Micronesia—Insects of Micronesia, Bernice P. Bishop Museum  
 Jour. Coll. Agri. Sappora—Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo  
 Jour. Kans. Ent. Soc.—Journal of the Kansas Entomological Society  
 Livro hom. d'Almeida—Livro de homenagem a R. F. d'Almeida  
 Mem. Dept. Agric. Ind. Ent.—Memoirs of the Department of Agriculture in India, Entomological Series  
 Mem. Inst. Sci. Madagascar—Memoires de l'Institut Scientifique de Madagascar  
 Mon. Geoc. Fenn.—Monographia Geocorisarum Fenniae  
 Nomen. Ent.—Nomenclator Entomologicus. Verzeichniss der europaischen Insecten  
 Not. Sallsk. Fauna Flor. Fenn.—Notiser ur Forhandlingar Sallskapets pro Fauna et Flora Fennica  
 Occas. Papers Mus. Zool. Mich.—Occasional Papers of the Museum of Zoology, University of Michigan  
 Ofv. Finska Vet.-Soc. Forh.—Ofversigt af Finska Vetenskaps-Societetens Forhandlingar  
 Proc. Cal. Acad. Sci.—Proceedings of the California Academy of Sciences  
 Proc. Haw. Ent. Soc.—Proceedings of the Hawaiian Entomological Society  
 Proc. Iowa Acad. Sci.—Proceedings of the Iowa Academy of Science  
 Proc. U.S. Nat. Mus.—Proceedings of the United States National Museum  
 Publ. Cult. Comp. Diam. Angola—Publicações Culturais de Companhia de Diamantes de Angola  
 Rec. S. Austr. Mus.—Records of the South Australian Museum  
 Rev. Brasil. Biol.—Revista Brasileira de Biologia  
 Rev. Chil. Ent.—Revista Chilena de Entomologia  
 Rev. d'Ent.—Revue d'Entomologie  
 Rev. Ent. R. J.—Revista de Entomologia, Rio de Janeiro  
 Rev. Fr. Ent.—Revue Francais d'Entomologie  
 Rev. Gall.—Revista Gallescencia, Medellin  
 Rev. Zool. Bot. Afr.—Revue de Zoologique et de Botanique Africaines  
 S. Afr. Anim. Life—South African Animal Life, Results of the Lund University Expedition in 1950–1951  
 Sjostedt Kilim. Meru Exp.—Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru, und den Ungebenden Massaiesteppen Deutsch-Ostafrikas, 1905–1906, unter Leitung von Prof. Dr. Yngve Sjostedt  
 Soc. Sci. Fenn. Comm. Biol.—Societas Scientiarum Fennica, Commentationes Biologicae  
 Studia Ent.—Studia Entomologica  
 Syst. Rhyng.—Systema Rhyngotorum Secundum Ordines, Genera, Species, Adjectis, Synonymis, Locis, Observationibus, Descriptionibus  
 Trans. IX Int. Congr. Ent.—Transactions of the IXth International Congress of Entomology  
 Ueber Arb. Schles. Ges.—Uebersicht der Arbeiten unde Verandereungen des Schlesischen Gesellschaft fur Vaterlandische Kultuir



U.S. Dept. Agric. Tech. Bull.—United States Department of Agriculture Technical Bulletin

U.S. Geol. Surv. Prof. Paper—United States Department of Interior, Geological Survey, Professional Paper

Wasmann Jour. Biol.—Wasmann Journal of Biology

Wien. Ent. Monat.—Wiener Entomologische Monatschrift

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## THE *CHIMARRA* (TRICHOPTERA: PHILOPOTAMIDAE) OF EASTERN NORTH AMERICA WITH DESCRIPTIONS OF THREE NEW SPECIES

PAUL K. LAGO AND STEVEN C. HARRIS

Biology Department, The University of Mississippi,  
University, Mississippi 38677, and  
Aquatic Biology Program, Department of Biology,  
University of Alabama, Tuscaloosa, Alabama 35486

**Abstract.**—Ten species of *Chimarra* (Trichoptera: Philopotamidae) are recorded from eastern North America, three of which are described as new: *C. falculata*, *C. holzenthali* and *C. parasocia*. Illustrations of male genitalia of each species are presented along with notes on distribution, a discussion of variation a key to species, and a phylogeny for the species.

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During recent surveys of the Trichoptera of several areas in the southeastern United States (Harris et al., 1982; Lago et al., 1982), it became apparent that the seven names existing for eastern *Chimarra* were inadequate for placing many of the specimens being collected. In attempting to solve this taxonomic problem, we examined many specimens from several major museums, and specimens sent to us by various colleagues as well as those in our collections. During this work, three undescribed species were discovered and are herein described. Illustrations of male genitalia are provided both for the new species and for the seven species previously known to occur in eastern North America, and a key to the species is presented along with notes on variation and geographic distribution. For our purposes “eastern” also includes the column of states on the western edge of the Mississippi River.

We gratefully acknowledge the assistance of the following individuals who made specimens available for this study: D. S. Chandler, University of New Hampshire; D. A. Etnier, University of Tennessee; J. F. Flannagan, Freshwater Institute, Winnipeg; O. S. Flint, Jr., National Museum of Natural History; P. H. Freytag, University of Kentucky; R. W. Holzenthal and J. C. Morse, Clemson University; B. C. Kondratieff, Colorado State University; T. L. McCabe, New York State Museum; A. P. Nimmo, University of Alberta; G. A. Schuster, Eastern Kentucky University; J. D. Unzicker, Illinois Natural History Survey; C. Vogt, Museum of Comparative Zoology; J. R. Voshell, Jr., Virginia Polytechnic Institute and State University; R. D. Waltz, Purdue University; and G. B. Wiggins, Royal Ontario Museum. We also wish to thank D. G. Denning for comparing specimens of *C. mosleyi* Denning with the holotype of the species.

Ross (1944) treated four species of *Chimarra* (*C. aterrima* Hagen, *C. feria* Ross, *C. obscura* (Walker) and *C. socia* Hagen) known to occur in Illinois and presented a description of *C. florida* from Georgia and Florida. He also included in his list *C. angustipennis* Banks and listed Arkansas, Oklahoma and Texas as distributional records for the species. According to Trivette (1969) the Arkansas record is attributable to misinterpretation of label data on the lectotype, “Ar” referring to Arizona,

not Arkansas. This species is not known to occur further east than central Oklahoma (Trivette, 1969), and consequently was not considered in the present study. As is true for many caddisfly genera, Ross's monograph (1944) has remained the standard for identification of the eastern *Chimarra* for the last 40 years. Only two new eastern species have subsequently been described, *C. moselyi* Denning (1947) from Georgia and *C. augusta* Morse (1971) from South Carolina. *Chimarra perigua*, was described by Ross (1948) from Florida, Georgia and Illinois, but, as was indicated by Denning (1950), it is synonymous with *C. moselyi*.

Armitage (1983) brought together much previously published and unpublished information on *Chimarra* and presented a key to males of the North American species. Trivette (1969), in his study of the *Chimarra* of western North America, recognized five species groups within the subgenus *Chimarra*, and during our work, we have found that placement of the eastern species into complexes similar to those formed by Trivette to be very useful. The "species complexes" defined below should be considered, along with those of Trivette (1969), as subsets of the *Chimarra aterrima* group as defined by Ross (1956, 1959). Phylogenetic relationships between the species considered here are discussed later in this paper.

We have not considered females in this paper because reliable characters have not yet been found that will separate all species. We do have associated females of all species and are continuing our study of that material. The following abbreviations refer to structures labelled on the accompanying illustrations: AR—aegeal rod, Inf—inferior appendage, Int—intermediate appendage, PA—preanal appendage, VP—mesal process on sternum IX.

#### KEY TO MALES OF *CHIMARRA* OF EASTERN NORTH AMERICA

1. Median projection on sternum IX linear and elongate (Fig. 6A) ..... *C. obscura* (Walker)
- Median projection on sternum IX short and triangular (Fig. 1A) or spatulate (Figs. 8A, 9A) ..... 2
2. Apex of ventral wall of aedeagus enlarged and usually distinctly hooked (Fig. 7F, G) ..... *C. florida* Ross
- Apex of ventral wall of aedeagus variously curved ventrad (Fig. 8C) or dorsad (Fig. 5C) or unmodified, never enlarged nor strongly hooked ..... 3
3. Inferior appendages dorsally elongated (Figs. 5A, 8A), without a mesal spur (Fig. 7C–E) ..... 4
- Inferior appendages quadrate or triangular in lateral view (Figs. 1A, 3A); in caudal view, each appendage possessing a transverse dorsal spur (Figs. 1C, 3B) ..... 7
4. Apex of ventral wall of aedeagus curved dorsad, usually hidden by sclerotized, hood-shaped tergum X (Fig. 5A, C); intermediate appendages narrow, nearly parallel sided, in dorsal view (Fig. 5B) and falcate in lateral view (Fig. 5A); ventral aedeagal rods robust and curved (Fig. 5D) ..... *C. falcata*, n. sp.
- Apex of ventral wall of aedeagus curved ventrad (Figs. 8C, 9C); intermediate appendages spatulate in dorsal view (Fig. 9B), not particularly acute in lateral view; ventral aedeagal rods elongate (Figs. 8D, 10D) ..... 5
5. Ventral aedeagal rods distinctly angulate, the apices divergent (Fig. 10D) ..... *C. moselyi* Denning
- Ventral aedeagal rods sinuate or evenly curved, not angulate (Figs. 8C, 9D) ..... 6
6. Ventral process on sternum IX short, about one-third the length of the inferior appendages and broadened subapically, about one-third as wide as long (Fig. 8A); ventral

- aedeagal rods with ventro-mesal spine at point where apices bend dorsad (Fig. 8D), the apices projecting straight dorsad, parallel ..... *C. parasocia*, n. sp.
- Ventral process on sternum IX at least half as long as inferior appendages and broadened at mid-length, nearly half as wide as long (Fig. 9A); ventral aedeagal rods simple at apex (Fig. 9E), apices convergent, not parallel, in caudal view ..... *C. socia* Hagen
7. Inferior appendages, in caudal view, with high dorso-lateral shoulders, the dorsal margin appearing concave (Figs. 3B, 4B) ..... 8
- Inferior appendages, in caudal view, either without shoulders or with a relatively short dorso-lateral projection (Figs. 1C, 2B), the dorsal margin appearing slightly sinuate or convex ..... 9
8. Sclerotized lobe beneath dorsal spur of inferior appendages narrow or finger-like in caudal view (Fig. 4B); intermediate appendages with recurved hook at apex (sometimes not strongly developed) and median lobe not particularly well developed (Fig. 4A); ventral aedeagal rod strongly curved dorsad apically, crossing dorsal rod (Fig. 4C) ..  
..... *C. feria* Ross
- Sclerotized lobe beneath dorsal spur of inferior appendages rounded (Fig. 3B); intermediate appendages with strongly developed median lobe and enlarged apex (Fig. 3A); with an apical mesally-projecting spine; configuration of aedeagal rods as in Figure 1C ..... *C. holzenthali*, n. sp.
9. Base of intermediate appendages with enlarged dorsally projecting lobe, median and apical lobes similarly well developed; inferior appendages gourd-shaped (lateral view), with narrow dorsal lobe curving caudad (Fig. 2A) ..... *C. augusta* Morse
- Base of intermediate appendages not enlarged, median and apical lobes enlarged, the apical lobe often appearing as a slightly recurved hook; inferior appendages more or less quadrate or triangular (Fig. 1A) ..... *C. aterrima* Hagen

ATERRIMA COMPLEX

Four closely related eastern species of *Chimarra* belong to this easily definable complex. Characteristically the species possess a short, pointed, triangular process on sternum IX; elongate, asymmetrical aedeagal rods; a sinuate, “twisted” and elongate dorso-lateral ridge on the intermediate appendages; and triangular to quadrate inferior appendages with mesally projecting, dorsal spurs. Included here are *aterrima* Hagen, *augusta* Morse, *feria* Ross, and *holzenthali*, n. sp.

*Chimarra aterrima* Hagen  
Figs. 1, 11

*Chimarrha aterrima* Hagen, 1861:297; Ross, 1944:50.

This is the most widely distributed and most familiar member of the species complex. As is true for most species with larger ranges, some variation in morphology is observable. Indeed, one need only examine the published illustrations of genitalia to sense the variability of this species (or perhaps the variability of the artists’ hands). Some variation in the contour of the dorsal ridge of the intermediate appendages occurs as well as in the shape of the inferior appendages. The latter structures vary in shape from marginally quadrate (cf. Ross, 1956, fig. 118A) to a more typical triangular form. In some specimens the dorso-apical corner is prolonged into a short finger-like process, approaching *augusta* in this respect, but even in these specimens the caudal face of the appendages appears flat, not excavated. This process appears



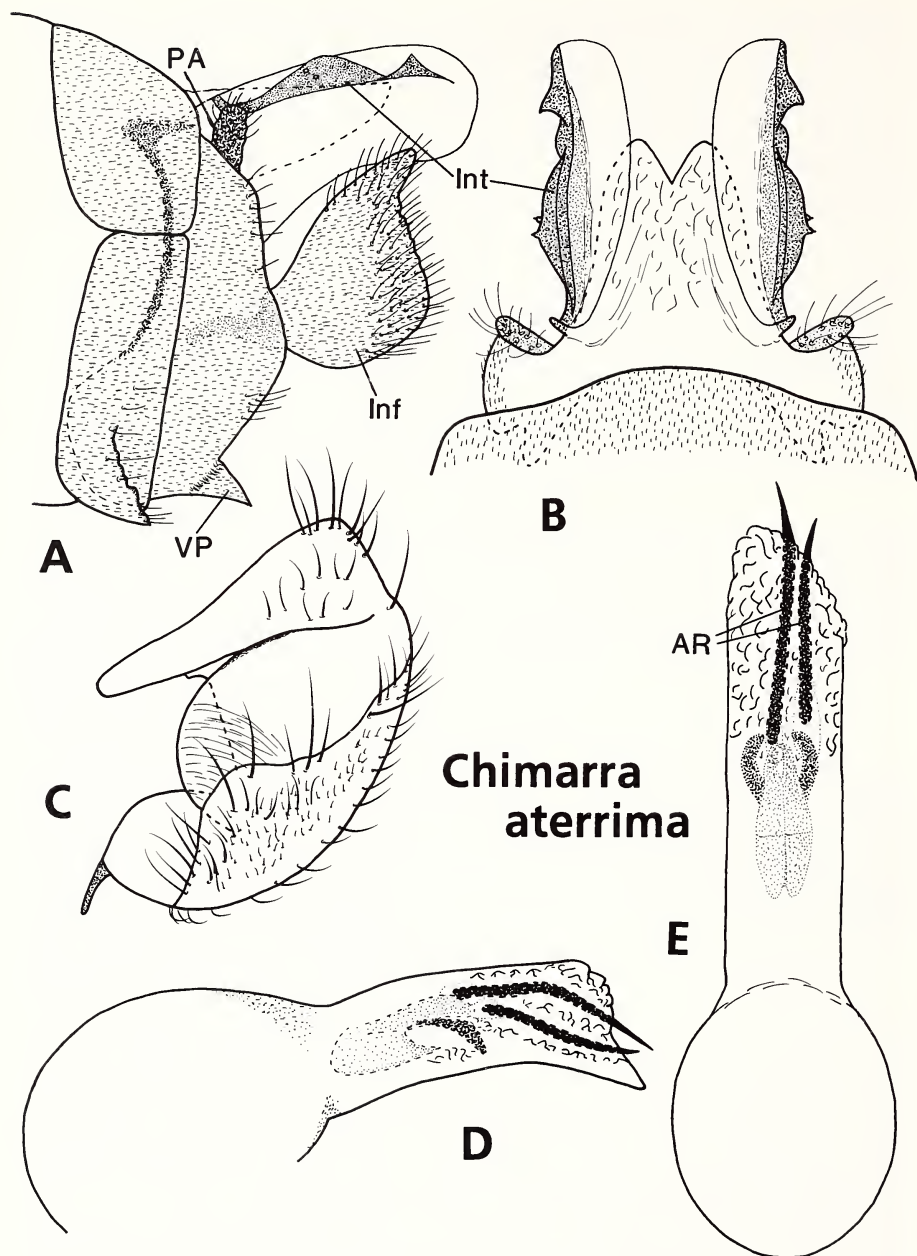


Fig. 1. *Chimarra aterrima* Hagen, male genitalia. (A) Lateral view. (B) Dorsal view. (C) Right inferior appendage, caudal view. (D) Phallus, lateral view. (E) Phallus, ventral view.

as a short shoulder when viewed caudally (cf. Ross, 1944, fig. 183), but the shoulder is never as greatly developed as in *feria*, or the new species *holzenthali*, described below. Variation appears to be isolated, not clinal. Specimens from Canada and New England do not differ in any consistent manner from southeastern specimens.

*Distribution.* Eastern half of North America (Fig. 11), north to approximately the 50th parallel in Canada (Schmid, 1982), west to northeastern Minnesota and western Texas (Edwards, 1973), and south to the Gulf Coast. This species has been reported from 26 eastern states (Armitage, 1983), no new state records were added during this study.

*Chimarra augusta* Morse

Figs. 2, 11

*Chimarra augusta* Morse, 1971:77.

The most distinctive features of this species are the enlarged basal lobe of the sclerotized ridge on the intermediate appendages and the caudally expanded ventral region of the inferior appendages (lateral view) (Fig. 2). Additionally the aedeagal rods bear long setae apically. All of these characters are unique among the members of the *aterrima* complex.

*Distribution.* This species is restricted to the southern Appalachian region (Fig. 11). Specimens have been collected in West Virginia, Virginia, Tennessee, South Carolina and Alabama.

*Chimarra holzenthali*, new species

Figs. 3, 11

*Description.* MALE. Length 6 mm. Dark brown, abdomen and legs yellowish brown, structure typical for genus. Genitalia as in Figure 3. Ninth segment narrowed dorsally and with a short triangular mesal projection on the sternite, as is true for other members of the *aterrima* complex. Tergum X divided into a pair of vertical intermediate appendages separated by a median triangular membranous lobe. Dorsolateral sclerotized ridge on each intermediate appendage strongly produced; basal region thickened but without a lobe, median lobe greatly enlarged with two sensillae located on separate apical tubercles, apical region less enlarged, broadly triangular, with a short, apical point projecting mesally. Preanal appendages longer than in other members of the group, with scattered short setae, and situated subdorsally at the base of tergite X. Inferior appendages in lateral view similar to those of *augusta* except less expanded basally; in caudal view, most similar to those of *feria*, caudal face excavated, with pronounced dorsal hollow shoulder, dorsal spur slender and directed mesad, lobe beneath spur rounded and heavily sclerotized. Phallus tubular, membranous apex with two curved, dorsal sclerotized rods which are relatively longer and more slender than those of other species in the complex, and two shorter ventral rods.

*Holotype.* ♂. LOUISIANA, *Jackson Parish*, Schoolhouse Spring, T17N-R1W-Sec 12, 24 Aug. 1973, J. C. Morse.

*Paratypes.* 3♀♀, same data as holotype; 1♂ and 1♀, same location, 14 Sept. 1973, C. E. Dunn, C. L. Smith and J. Louton (genitalia of the male cleared to the point

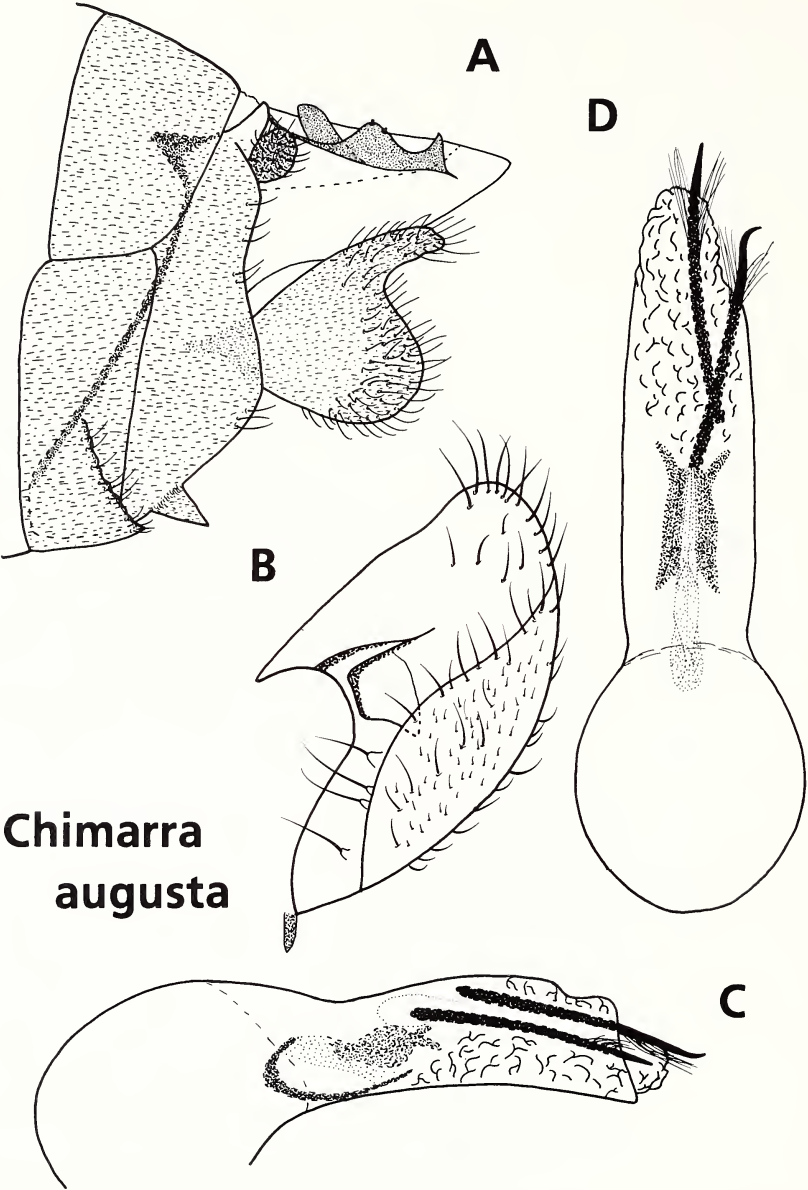


Fig. 2. *Chimarra augusta* Morse, male genitalia. (A) Lateral view. (B) Right inferior appendage, caudal view. (C) Phallus, lateral view. (D) Phallus, ventral view.

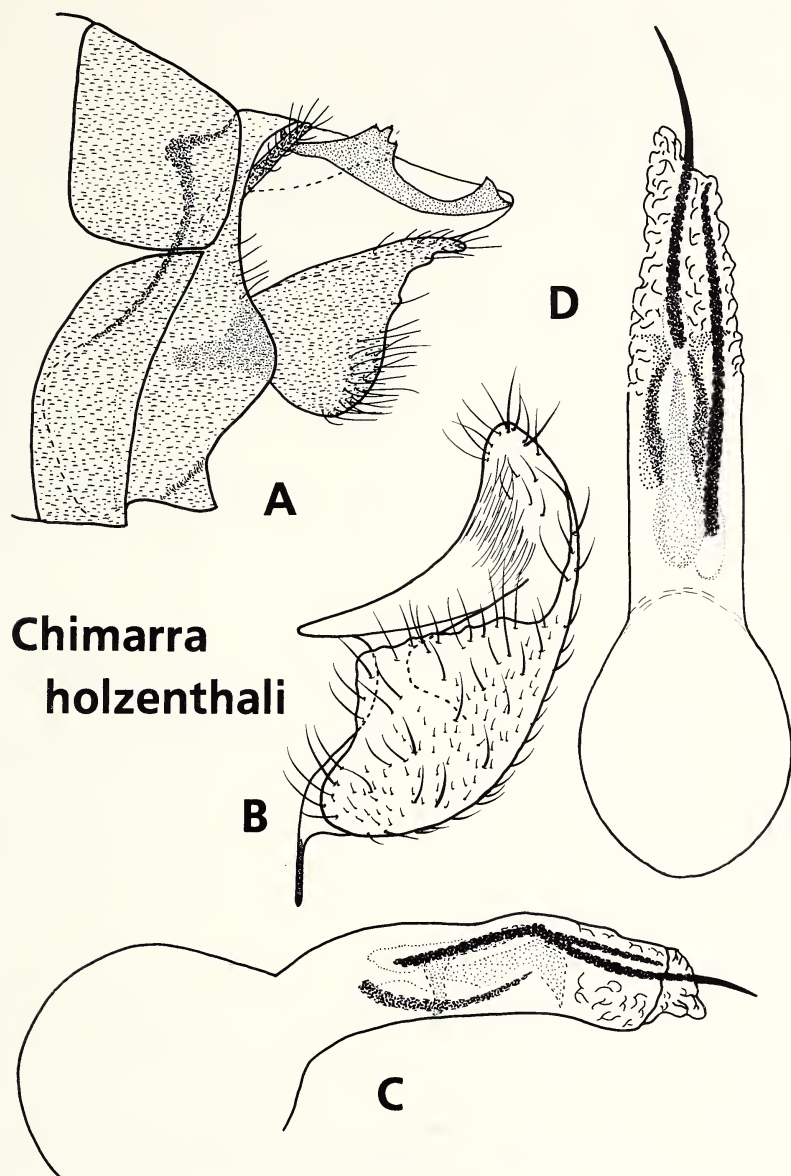


Fig. 3. *Chimarra holzenthali*, n. sp., male genitalia. (A) Lateral view. (B) Right inferior appendage, caudal view. (C) Phallus, lateral view. (D) Phallus, ventral view.



where totally transparent); and 1♂, same location, 7 July 1973, J. C. Morse (genitalia lost after comparison with holotype).

The holotype is deposited in the U.S. National Museum of Natural History, the paratypes are in the Clemson University Entomological Collection.

*Diagnosis.* This species resembles closely the other members of the *aterrima* complex. The shape of the sclerotized ridge on the intermediate appendages is distinctive as are the elongate preanal appendages. The inferior appendages resemble in some respects those of *augusta* and *feria*, differing as indicated in the above description. These appendages in *aterrima*, as in *augusta*, lack the high, dorsal lateral shoulder (caudal view) present in both *feria* and *holzenthali*, although a small shoulder may be present in some *aterrima*. Additionally the caudal face of the inferior appendages is flat in *aterrima* and deeply excavated in *holzenthali*, and the sclerotized lobe beneath the dorsal spur is very large in *aterrima* and smaller and less pronounced in *holzenthali*.

*Distribution.* Known only from the type locality in north-central Louisiana (Fig. 11).

*Etymology.* We take great pleasure in naming this species for Ralph W. Holzenthali, who brought these specimens to our attention and also provided many other specimens critical to this study.

*Chimarra feria* Ross

Figs. 4, 11

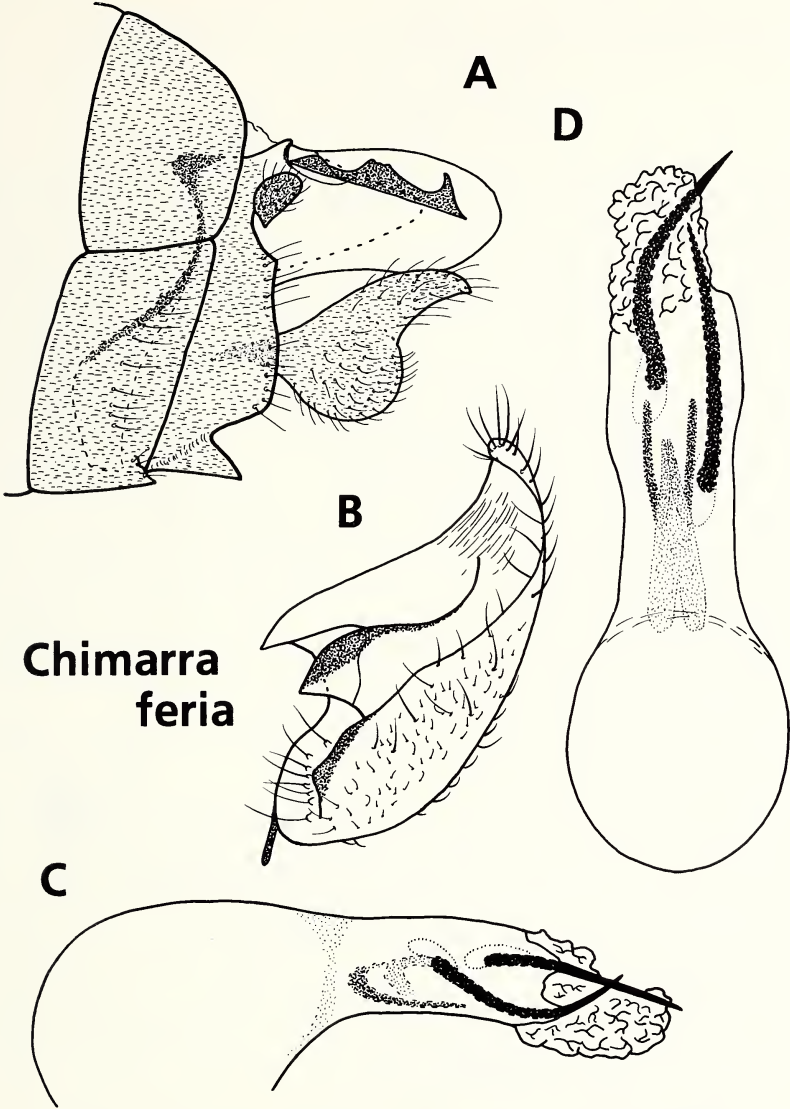
*Chimarra feria* Ross, 1941:51–52; Ross, 1944:50–51.

Perhaps the most distinctive species in the complex, specimens of *feria* can usually be recognized at once by the dorso-lateral shoulders and the excavated caudal face of the inferior appendages, and by the arrangement of the aedeagal rods where one rod ("ventral") appears to be sharply curved dorsad, crossing the second rod (Fig. 4). The inferior appendages are most similar to those of *holzenthali*, but differ in that the sclerotized lobe beneath the dorsal spur (caudal view) is an acute finger-like process, whereas in the latter it is a rounded lobe.

*Distribution.* Central United States east of the Great Plains. Southwestern Ontario east to southern Quebec and Newfoundland (Schmid, 1982) south to south-central Texas (Fig. 11). This species has a very limited east–west distribution in the United States, a pattern fitting well that given by Ross (1944) in defining a Northeastern-Ozark species. The specimen of "*C. feria*" reported from Kentucky by Resh (1975) is, in fact, *aterrima*, as are those reported from Claiborne and Lincoln counties in Mississippi by Lago et al. (1982). With the exception of Kentucky, *feria* has been reported from the states indicated by Armitage (1983), no new state records were added during this study.

OBSCURA COMPLEX

This group is not as homogeneous as the *aterrima* complex. The species included here have dorsally elongated, curved inferior appendages and have the ventral wall of the phallus extended apically and free from membranes of the aedeagus, and the



**Chimarra  
feria**

Fig. 4. *Chimarra feria* Ross, male genitalia. (A) Lateral view. (B) Right inferior appendage, caudal view. (C) Phallus, lateral view. (D) Phallus, ventral view.

aedeagal rods are symmetrical. Included here are *falculata*, n. sp., *florida* Ross, *moselyi* Denning, *obscura* (Walker), *parasocia*, n. sp., and *socia* Hagen.

***Chimarra falculata*, new species**

Figs. 5, 12

*Description.* MALE. Length 7 mm. Generally dark brown to nearly black, abdominal sterna and femora lighter brown in some specimens. Structure typical for genus. Genitalia as in Figure 5. Sternum IX ventrally with a short rounded or triangular projection which is emarginate and darkened apically. Median lobe of tergum X lightly sclerotized, elongate, and hood-shaped, normally concealing entire phallus; intermediate appendages falcate, with ventro-basal rounded projection, down-curved apical portion, and acute apex in both lateral and dorsal views. Preanal appendages prominent, attached to base of lateral lobes. Inferior appendages, in lateral view, elongate, linear, slightly expanded apically with a strong spine or triangular projection on the posterior margin near the apex; base with acute ventral projection; in caudal view, base expanded mesally and saucer-like (as in *florida*), remainder evenly arcuate to acute tip. Phallus tubular, lightly sclerotized except for dorso-apical membrane; ventral wall tapering to truncate or concave apical margin, curving dorsad apically. Aedeagus with two pairs of rods; ventral pair heavily sclerotized, short and robust, evenly curved with ends pointing dorsad in lateral view and laterad in ventral view; dorsal pair very lightly sclerotized, more elongate, and straighter than ventral pair, apparently fused mesally, each with an elongate, lateral accessory spine distally lying parallel to main rod giving the central structure a fork-like appearance distally in ventral view (evident only under high magnification).

*Holotype.* ♂. ALABAMA, *Mobile Co.*, Puppy Creek at Co. Hwy 217, 7 mi SW Citronelle, 12 May 1982, S. C. Harris, light trap.

*Paratypes.* ALABAMA, *Baldwin Co.*, Red Hills Creek at Hwy 59, 18 Aug. 1983, S. C. Harris, 1♂, *Covington Co.*, Blue Spring, Conecuh Nat. For., 22 Apr. 1981, Harris/O'Neil, 1♂; *Escambia Co.*, Blackwater River at Co. Hwy 4, 12 June 1982, S. C. Harris, 1♂. FLORIDA, *Walton Co.*, Eglin Air Force Base, Rocky Creek, 4 mi SW Mossy Head, 14 Mar. 1979, J. F. Scheiring, 1♂; same data except 25 Apr. 1979, 37♂♂; same data except 11 May 1979, 35♂♂; same data except 8 June 1979, 34♂♂; same data except 16 Aug. 1979, 36♂♂; same data except 19 Sept. 1979, 9♂♂. GEORGIA, *Crawford Co.*, below pond on Spring Creek at Camp Eunice 5 mi SSE of Roberta, 5 June 1981, S. W. Hamilton and M. Rothschild, 4♂♂. MISSISSIPPI, *Stone Co.*, University of Mississippi forest lands, headquarters, 19 May 1978, P. K. Lago, 1♂; same data except 22 May 1980, 1♂; same data except 24 May 1980, 2♂♂.

The holotype and three paratypes are deposited in the United States National Museum of Natural History. The remaining paratypes are deposited at the Illinois Natural History Survey, Clemson University, the Royal Ontario Museum and in the collections of the authors.

*Diagnosis.* The linear form of the inferior appendages, falcate intermediate appendages, and the upturned ventral wall of the phallus will separate specimens of this species from other North American members of the genus. The sclerotized, hood-shaped tenth tergum is also unique. Variation is limited. Specimens from

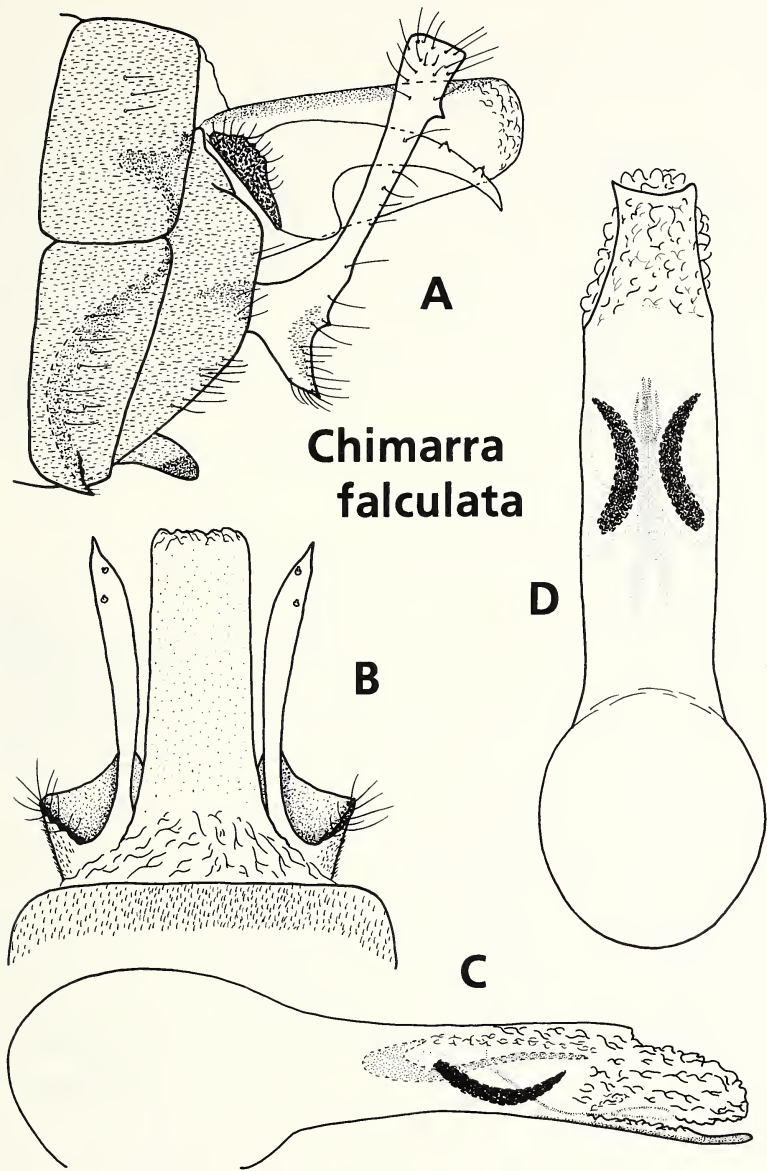


Fig. 5. *Chimarra falculata*, n. sp., male genitalia. (A) Lateral view. (B) Dorsal view. (C) Phallus, lateral view. (D) Phallus, ventral view.



Florida were slightly lighter in color and one specimen from Alabama had inferior appendages that were very thin in lateral view.

*Chimarra ferculata* is unique in many respects and does not seem particularly closely related to any other species in this complex. This is the undescribed species listed by Harris et al. (1982) from Eglin Air Force Base in Florida, and is one of the species included in the *socia-moselyi* complex by Lago et al. (1982). In both cases, alliance of this species with *socia* was based on the shapes of the inferior appendages and the ventral process on segment IX, and is probably not correct. Form of the aedeagal rods seems to indicate a somewhat closer relationship with *florida*.

*Distribution.* Southeast Coastal Plain from eastern Mississippi to central Georgia and the Florida panhandle (Fig. 12).

*Etymology.* Latin, *falc* (sickle) with diminutive suffix, meaning provided with a little sickle; referring to the sickle-shaped or falcate intermediate appendages.

*Chimarra obscura* (Walker)

Figs. 6, 13

*Beraea? obscura* Walker, 1852:121.

*Chimarrha obscura* (Walker), Hagen, 1861:297; Ross, 1944:51.

*Wormaldia plutonis* Banks, 1911:358; Betten and Mosely, 1940:19 (as syn. of *C. obscura*).

*Chimarrha lucia* Betten, 1934:175; Ross, 1938:7 (as syn. of *C. plutonis*).

This species proved to be the most confusing of all those encountered during this study. At one time we had divided our specimens into three species, but we now believe that the two forms we considered new actually represent variants of one wide-ranging and variable species.

Variation in the genitalia of *obscura* primarily involves the shape of the ventral aedeagal rods and the degree of development of the hook on the ventral wall of the phallus. The aedeagal rods in specimens from the northeastern United States are relatively short, robust and curved in ventral view (Fig. 6H). This is the form seen in the holotype, and the types of *W. plutonis* and *C. lucia*. Specimens from southern localities (Texas through South Carolina) have these rods more elongate and slender, and virtually straight or slightly angulate in ventral view, the tips of the rods parallel apically or nearly so (Fig. 6F). Until we examined series from Tennessee and Missouri, we had considered these two forms as representing distinct species; however, specimens from the middle states may have long or short rods (often both extremes are represented in the same sample) or may have rods of intermediate length and thickness. Additionally, in some specimens from Minnesota, the rods were typical of the "southern" form, and in a few specimens from Texas, these structures were quite similar to those of New England specimens, although they were consistently less robust.

The shape of the base of the phallobase varies from distinctly inflated (Fig. 6D) in northeastern specimens to moderately expanded (Fig. 6C) in western and southern populations. Intermediates occur, again, in the middle states along with individuals exhibiting either extreme. Contrary to the obvious pattern, some specimens with enlarged ("northern") bases also have elongate ("southern") aedeagal rods.

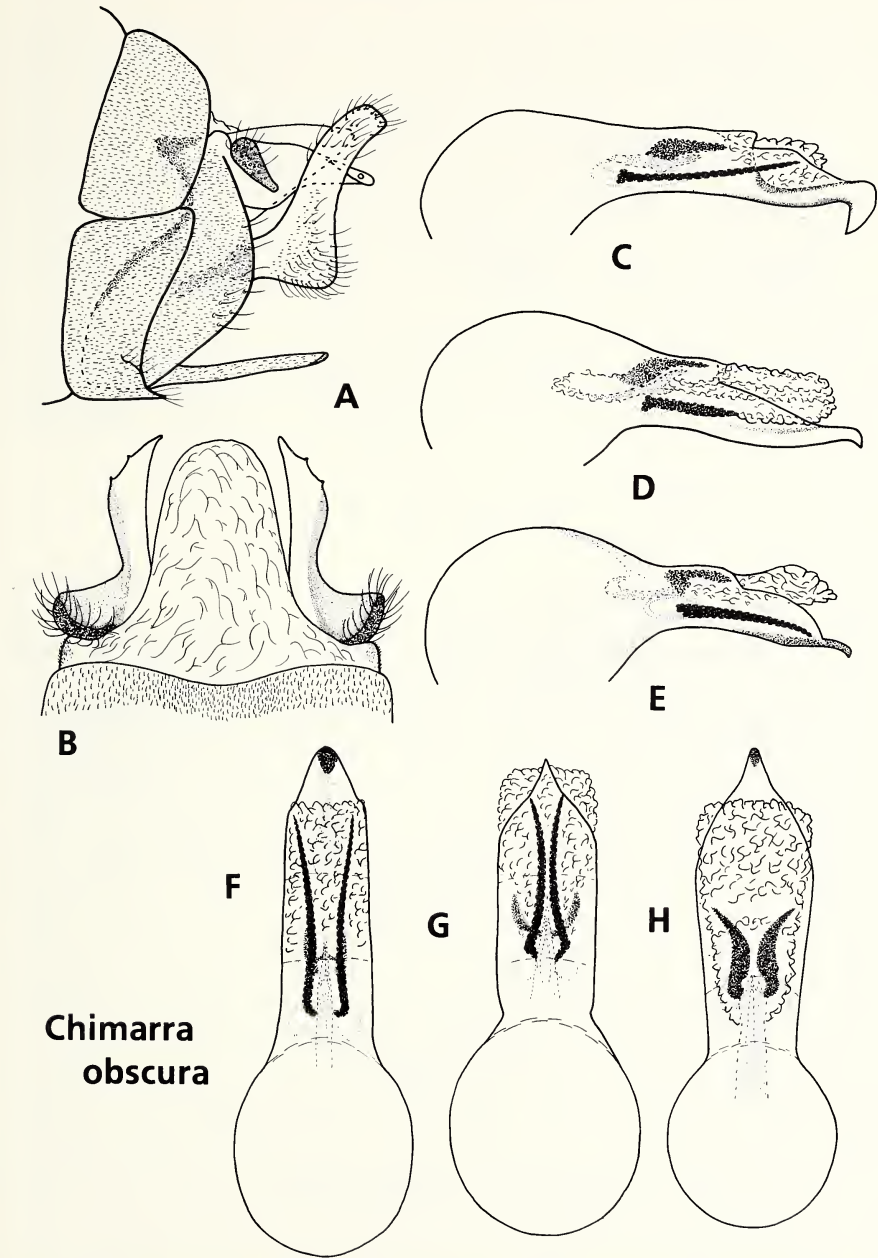


Fig. 6. *Chimarra obscura* (Walker), male genitalia. (A) Lateral view. (B) Dorsal view. (C-E) Phallus, lateral view. (C) Southern form. (D) Northeastern form. (E) Intermediate, Cumberland Co., Tennessee. (F-H) Phallus, ventral view. (F) Southern form. (G) Intermediate. (H) Northeastern form.

Variation in the size and shape of the apical hook on the apex of the phallus is pronounced. Specimens from throughout the range of the species have prominent hooks (as in Fig. 6C); however, these hooks are occasionally smaller (as in the holotype of *C. lucia*, Fig. 6D), or virtually absent (as in a population from Cumberland County, Tennessee, Fig. 6E). We originally considered this latter population to represent a separate species; but, with the exception of the reduced or absent hook, the genitalia are indistinguishable from those of typical *obscura*. Within this Tennessee series the base of the phallobase is enlarged and the aedeagal rods vary from short and curved to relatively long and straight. The specimen reported from Kentucky by Resh (1975) as *C. nr. obscura* is a typical "southern" form of *obscura* possessing long, straight aedeagal rods.

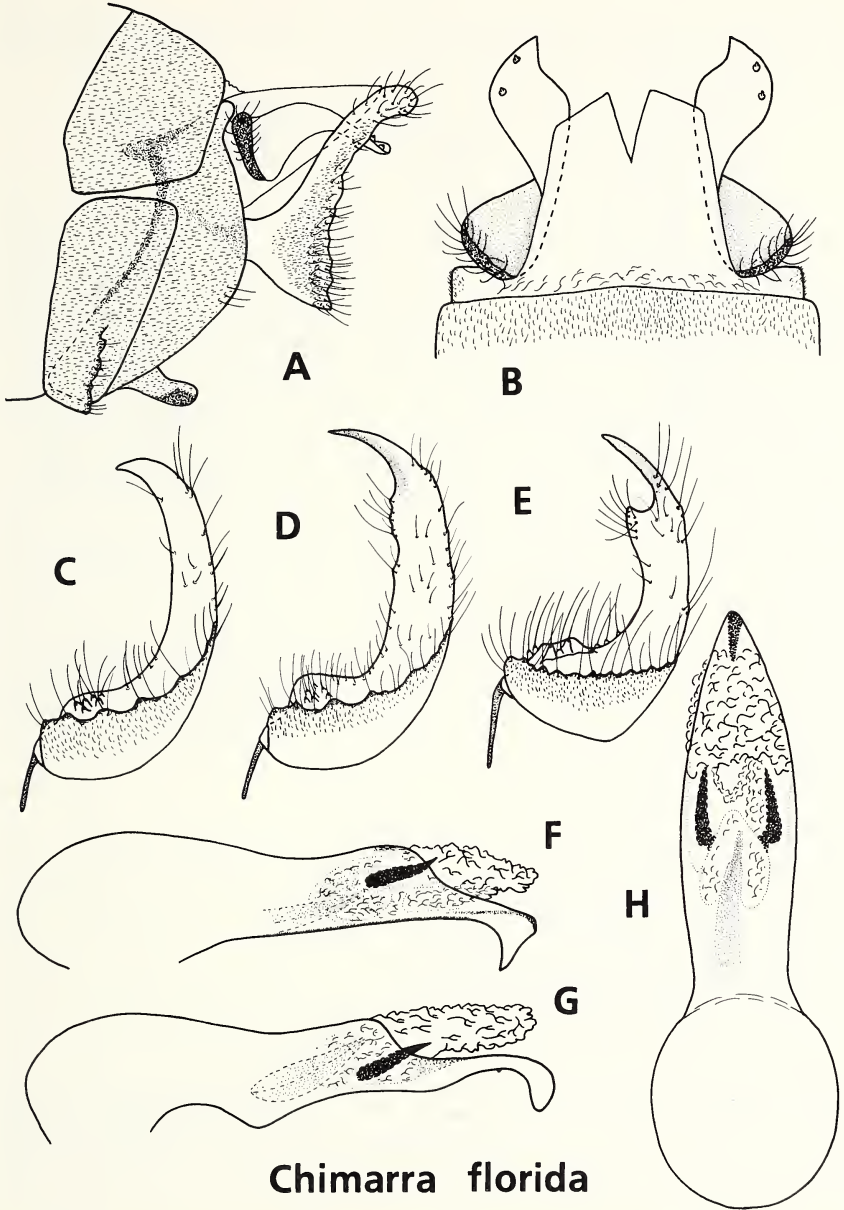
*Distribution.* Most of the eastern half of North America with the exception of a strip extending from extreme southeastern Alabama northward along the Atlantic Coast (Fig. 13). *Chimarra obscura* has been reported from 21 eastern states (Armitage, 1983); in addition to these, we examined specimens from Alabama and South Carolina.

*Chimarra florida* Ross

Figs. 7, 13

*Chimarra florida* Ross, 1944:270.

The close relationship between this species and *obscura* is indicated not only by the similarity of the male genitalia, but also by the fact that Ross (1944) was unable to separate females of the two species. Males of *florida* can at once be separated from those of *obscura* by the short ventral process on sternum IX. Also, the intermediate appendages are flattened and expanded apically (spatulate) in dorsal view, whereas, those of *obscura* are similarly flattened, but not spatulate; and the aedeagal rods in *florida* are comparatively shorter than those of *obscura*. Variation occurs in the shape of the inferior appendages and in the apical hook on the ventral wall of the phallus. In specimens from Mississippi, Louisiana and Alabama, the mesal margin of the inferior appendages, in caudal view, is quite evenly curved (Fig. 7C) and the hook on the aedeagus has acute apical and ventral points (Fig. 7F). In a series from New Jersey, the dorsal arm of the inferior appendages (in caudal view) is nearly straight, instead of curved, has a narrow, finger-like apical portion that projects mesad, and is deeply excavated mesally below the apex (Fig. 7E); and the hook on the aedeagus is rounded apically and obtuse ventrally (Fig. 7G). These differences initially led us to believe that two species were involved. However, specimens from Georgia and Florida showed character states intermediate between these two extremes. The type of *florida*, from Georgia, has inferior appendages that are straighter than those from further west; the apex is not excavated as in the New Jersey specimens; however, there is a definite angulation on the mesal margin (Fig. 7D) that is absent in Mississippi specimens. Other Georgia specimens examined had faint indications of excavations, and specimens from Florida vary from having no such excavations to having inferior appendages nearly identical to those seen in the New Jersey specimens. The hook on the phallus shows a similar southwest to northeast gradation from angulate to rounded. It seems best at present to consider this one highly variable species than to segregate the extremes into two species.



***Chimarra florida***

Fig. 7. *Chimarra florida* Ross, male genitalia. (A) Lateral view. (B) Dorsal view. (C–E) Right inferior appendage, caudal view. (C) Mississippi specimen. (D) Georgia specimen (holotype). (E) New Jersey specimen. (F, G) Phallus, lateral view. (F) Southern form (holotype). (G) New Jersey specimen. (H) Phallus, ventral view.



*Distribution.* *Chimarra florida* is a Coastal Plain species (Fig. 13); specimens have been collected in Louisiana, Mississippi, Alabama, Georgia, Florida and South Carolina, and also in Ocean County, New Jersey.

***Chimarra parasocia*, new species**

Figs. 8, 14

*Description.* MALE. Length 5.5 mm. Wings, abdomen, nota, antennae, and tibial spurs medium brown; thoracic sterna lighter, legs and palpi pale yellow. Structure typical for genus. Genitalia as in Figure 8. Sternum IX with a prominent spatulate mesal lobe ventrally, the latter similar to, but distinctly shorter and less robust than in either *socia* or *moselyi*. Tergum X semi-membranous; intermediate appendages sclerotized, extending caudad beyond tergum X, slightly sinuate in lateral view and spatulate in dorsal view (as in *socia* and *moselyi*); dorsal surface of appendages with two truncated, conical tubercles, each with a single short seta at its apex. Preanal appendages prominent, attached to base of intermediate appendages. Inferior appendages elongate; in lateral view, base enlarged and quadrate, densely setose on posterior margin, apex expanded with postero-apical corner prominent, apical margin truncate; in caudal view, evenly arcuate, base with prominent mesal lobe, apex strongly curved mesad, acute. Phallus with ventral wall, more strongly sclerotized in apical one-third, down-curved (as in *socia* and *moselyi*); tubular apically with two pairs of sclerotized rods internally, similar in general configuration to those of *socia*; ventral rods slender, slightly curved laterad, dorsal pair somewhat more robust and nearly as long as ventral pair, sinuate in both lateral and ventral views, distal ends abruptly curved dorsad, parallel, the up-curved portion longer and more acute than in *socia*, and with an accessory spine diverging meso-ventrally from the point where the rod bends dorsad.

*Holotype.* ♂. MISSISSIPPI, *Wilkinson Co.*, Buffalo River at Hwy 61, 24 June 1982, P. K. Lago, black light.

*Paratypes.* ALABAMA, *Bibb Co.*, Cahaba River at Co. Hwy 27, 25 Aug. 1981, Harris/O'Neil, 1♂; Schultz Creek, 4 mi N Centreville, 25 Aug. 1981, 1♂; *Dallas Co.*, Oakmulgee Creek at Hwy 219, 5 June 1981, S. C. Harris, 1♂; *Jefferson Co.*, Glenn Spring at Co. Hwy 20, Bessemer, 2 July 1982, Harris/Handley, 1♂; *Mobile Co.*, Grog Hall Creek, 4 mi S Mt. Vernon, 24 June 1982, S. C. Harris, 1♂; *Perry Co.*, Cahaba River at Suttle bridge, 5 June 1981, S. C. Harris, 6♂♂; Oakmulgee Creek at Co. Hwy 30, 15 June 1981, S. C. Harris, 1♂; *Shelby Co.*, Cahaba River at Hwy 52, 12 June 1981, Harris/O'Neil, 1♂; *Tuscaloosa Co.*, Sipsey River at Hwy 171, 15 June 1983, S. C. Harris, 1♂; Sipsey River at Hwy 82, 14 Apr. 1981, Harris/O'Neil, 9♂♂; Sipsey River at Co. Hwy 21, 7 Aug. 1981, Harris/O'Neil, 2♂♂; Turkey Creek at Hwy 69, 11 Aug. 1981, Harris/O'Neil, 2♂♂; North River at Co. Hwy 38 nr Samantha, 25 Sept. 1981, S. C. Harris, 1♂; Cripple Creek, 2 mi E Samantha, 11 Aug. 1981, Harris/O'Neil, 2♂♂; Tyro Creek 3.5 mi SE Berry, 25 July 1983, Harris/O'Neil, 2♂♂. ARKANSAS, *Montgomery Co.*, Little Missouri Riv. at Albert Pike Rec. Area, 30 May 1974, W. P. McCafferty, A. V. Provonsha and L. Dersch, 1♂. KENTUCKY, *Bell Co.*, Cumberland River, Pineville, 13 June 1940, Frison et al., 1♂. LOUISIANA, *Natchetoches Par.*, Little Bayou Pierre, 15 June 1974, J. A. Louton, 1♂; *St. Tammany Par.*, Abita Creek at Hwy 435, 4.5 mi E of Abita Springs, 5 June 1979, R. W. Holzenthal and

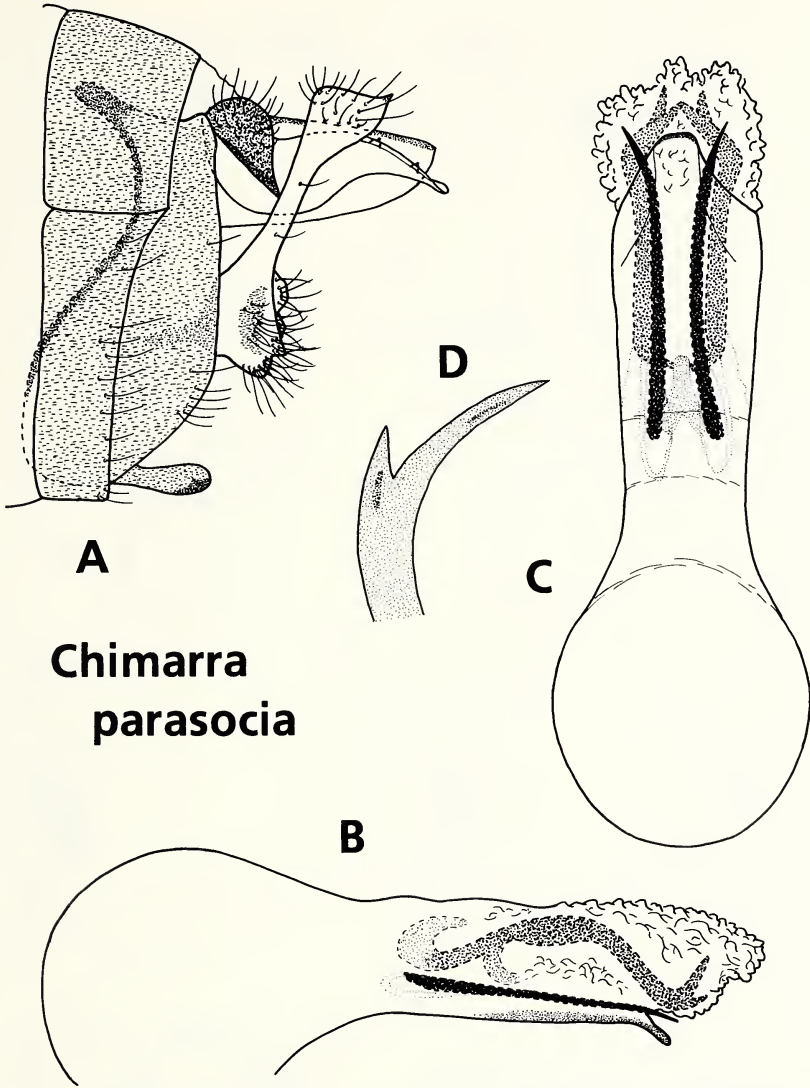


Fig. 8. *Chimarra parasocia*, n. sp., male genitalia. (A) Lateral view. (B) Phallus, lateral view. (C) Phallus, ventral view. (D) Apex of dorsal aedeagal rod.

M. Winter, 2♂♂; Morgan Branch, Bogue Falaya River at Hwy 25, 1.2 mi S of Folsom, 21 May 1979, R. W. Holzenthal and J. M. Grady, 2♂♂; *St. Helena Par.*, confluence of east and west prongs of Amite River, 6 Aug. 1979, R. W. Holzenthal, J. H. Grady, H. Bart and G. Laiche, 8♂♂. MISSISSIPPI, *Amite Co.*, East Fork Amite river on rd to Liberty, T1N-R4E-Sec. 27, 23 June 1979, R. W. Holzenthal, H. Bart, G. Laiche

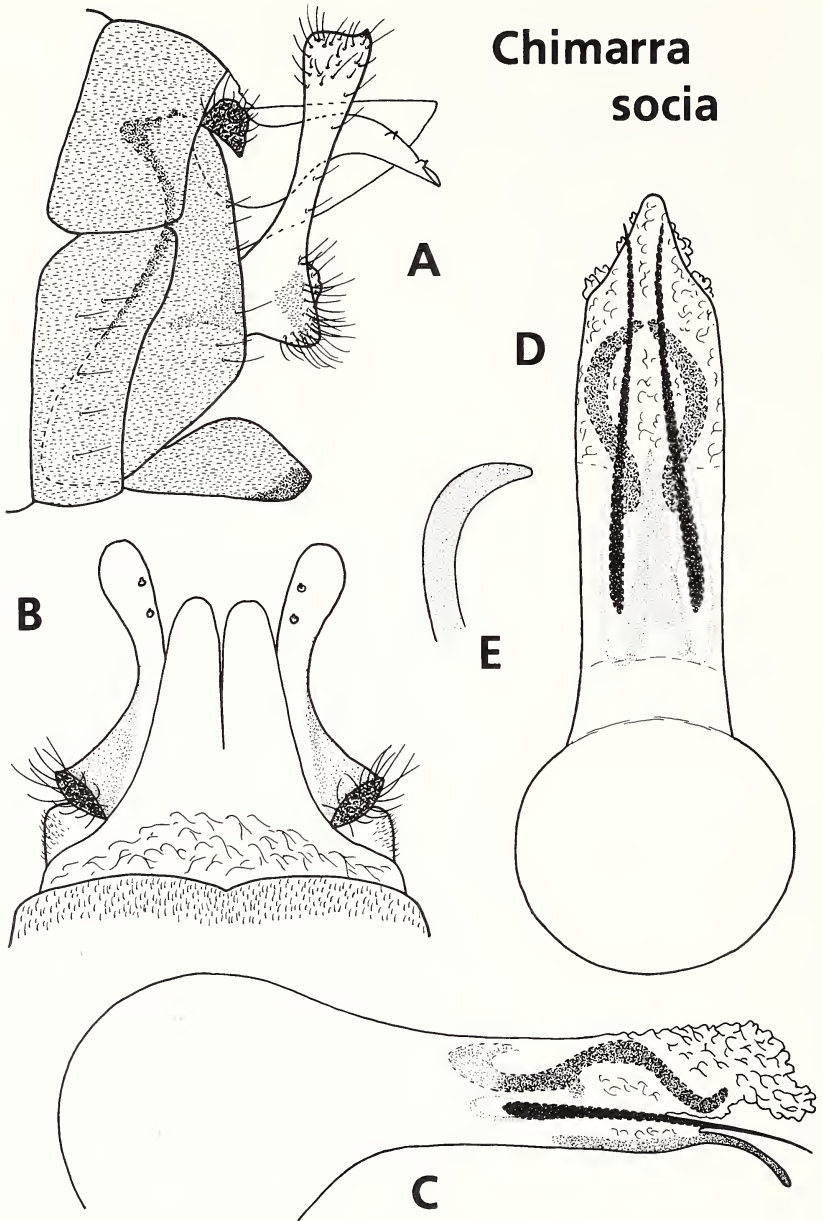


Fig. 9. *Chimarra socia* Hagen, male genitalia. (A) Lateral view. (B) Dorsal view. (C) Phallus, lateral view. (D) Phallus, ventral view. (E) Apex of dorsal aedeagal rod.

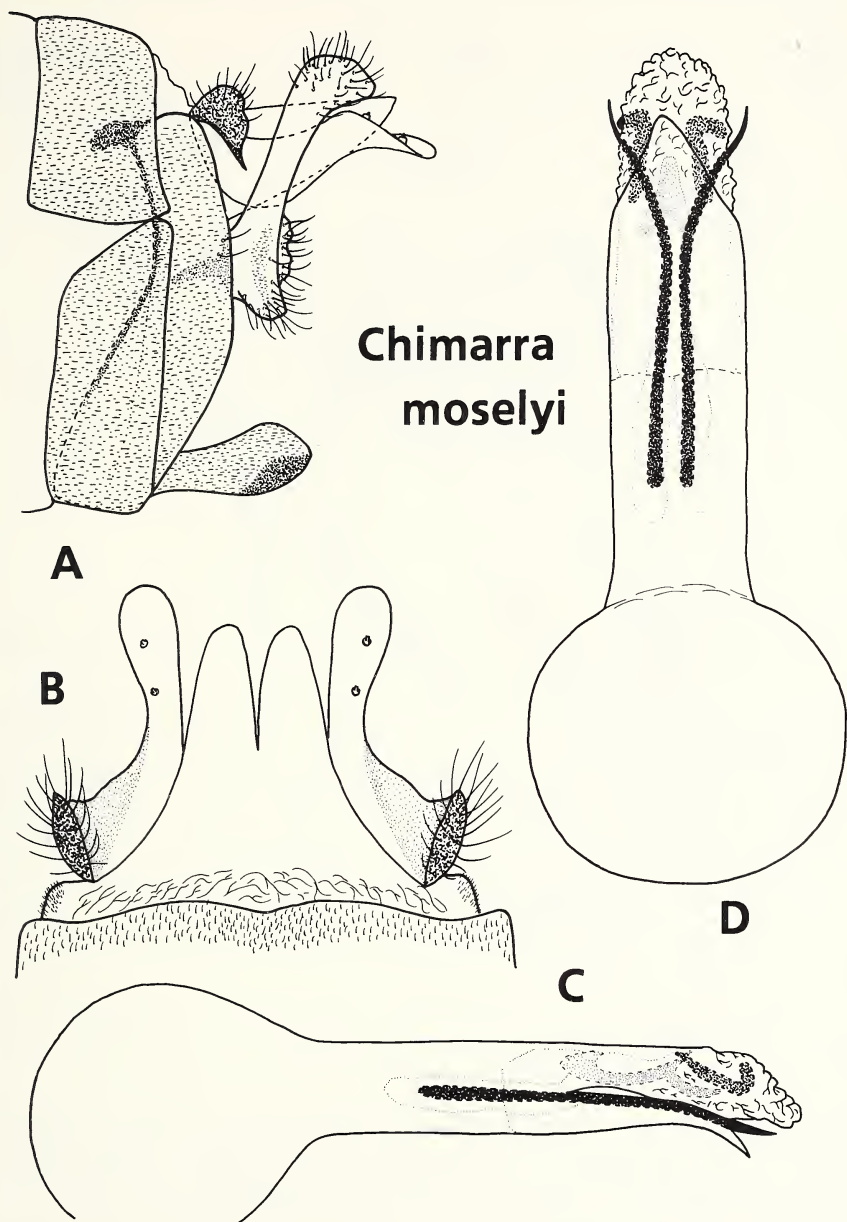


Fig. 10. *Chimarra moselyi* Denning, male genitalia. (A) Lateral view. (B) Dorsal view. (C) Phallus, lateral view. (D) Phallus, ventral view.



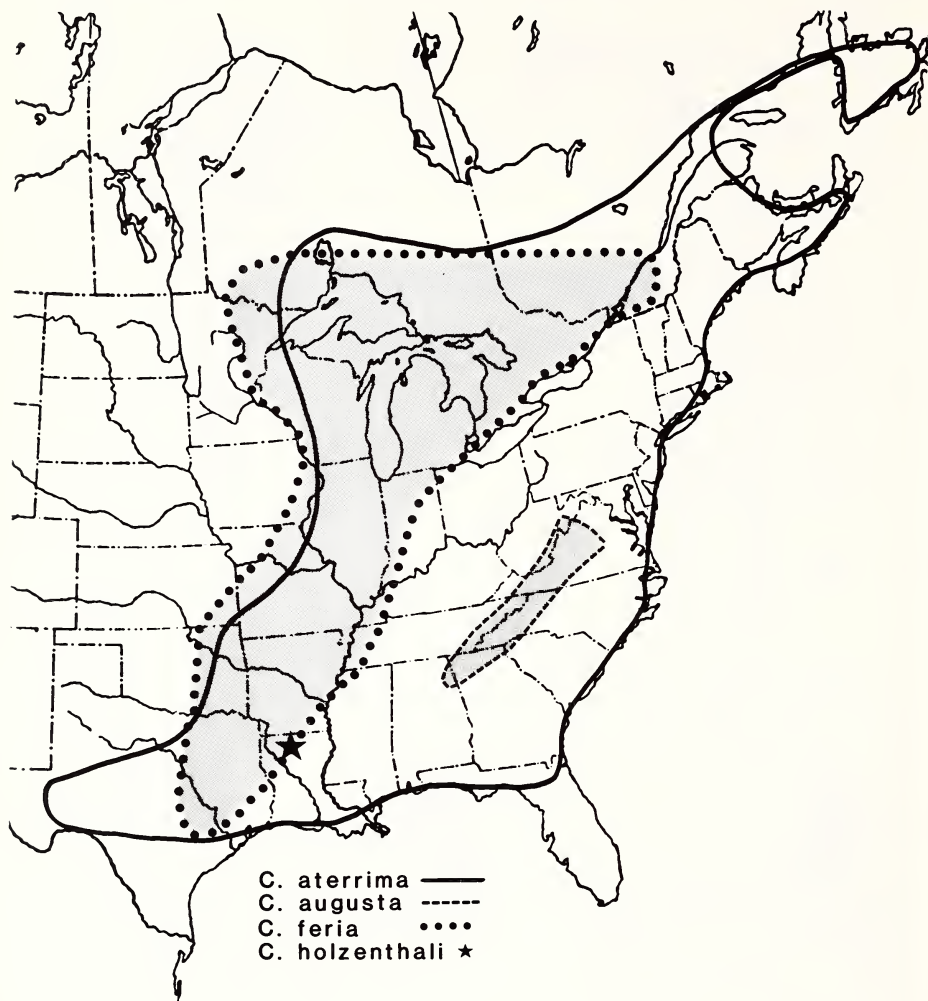


Fig. 11. Distribution of members of the *aterrima* complex.

and M. Chosa, 3♂♂; *Forrest Co.*, P. B. Johnson St. Pk., 30 Apr. 1981, P. K. Lago, 1♂; *George Co.*, Black Creek at Hwy 57, 11 Apr. 1981, P. K. Lago, 1♂; same locality, 1 May 1981, 5♂♂; *Green Co.*, 4 mi W State Line, Chickasawhay River, 20 May 1983, P. K. Lago, 6♂♂; *Lafayette Co.*, Oxford, 30 June 1983, P. K. Lago, 2♂♂; Oxford, 22 June 1980, P. K. Lago, 1♂; *Lamar Co.*, 5 mi N Baxterville, Half Moon Creek, 23 May 1980, P. K. Lago, 1♂; *Leake Co.*, Carthage, 8 May 1979, P. K. Lago, 1♂; *Lowndes Co.*, Lake Lowndes St. Pk., 23 June 1981, P. K. Lago, 2♂♂; *Pike Co.*, Tangipahoa River, 3 mi S Magnolia, 10 June 1977, B. Stark, 1♂; *Stone Co.*, Flint Creek at Hwy 26, 4.9 mi E Wiggins, 7 June 1979, R. W. Holzenthal, 1♂; *Tishomingo Co.*, Tish-

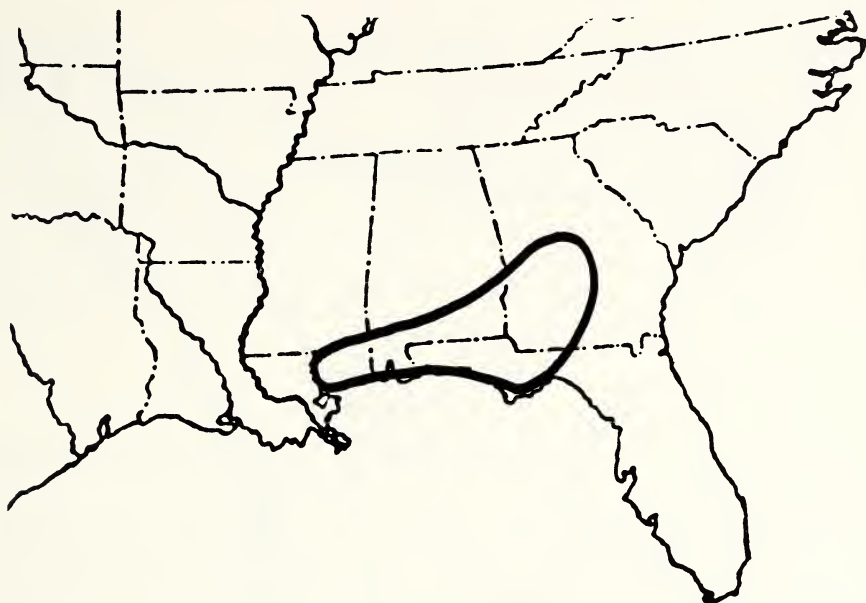


Fig. 12. Distribution of *C. falculata*, n. sp.

omingo St. Pk., 22 July 1978, S. Hurdle and P. K. Lago, 2♂, 2♀♀; same locality, 8 Sept. 1980, P. K. Lago, 5♂♂; *Wilkinson Co.*, same data as holotype, 9♂♂, 3♀♀. MISSOURI, *Wayne Co.*, Williamsville, 8 July 1948, Becker et al., 2♂♂; same data except 24 Aug. 1951, 2♂♂. TENNESSEE, *Lawrence Co.*, Loretto, 20 May 1957, 1♂; *Madison Co.*, Jackson, 13 May 1957, 1♂.

The holotype and three paratypes are deposited in the United States National Museum of Natural History. The remaining paratypes are deposited at the Royal Ontario Museum, Illinois Natural History Survey, Clemson University, Purdue University, the University of Tennessee, and in the collections of the authors.

*Diagnosis.* As the name implies, *parasocia* is closely related to *socia*, and is somewhat more distantly, but obviously, related to *moselyi*. Specimens of *parasocia* can be separated from these species by the smaller, less robust ventral process on segment IX. We have examined hundreds of specimens of these three species and have found this to be a very consistent character. We found no specimens that could be considered intermediate; however, this character is best appreciated when one has comparative material at hand. Specimens may also be separated by the form of the aedeagal rods. In both *socia* and *parasocia* the ventral rods are elongate and slightly curved (Figs. 8C, 9C) whereas in *moselyi* the same rods are strongly angulate with the basal two-thirds close together and nearly parallel and the apical portions strongly divergent (Fig. 10C). Additionally, the dorsal rods in *moselyi* are very short and abruptly bent laterad apically (Fig. 10D), but are elongate and sinuate in the other two species (Figs. 8, 9). The differences between *socia* and *parasocia* are a little more subtle, but equally constant. The dorsal rods of *socia* are simple apically (Fig. 9E) while those of *parasocia*

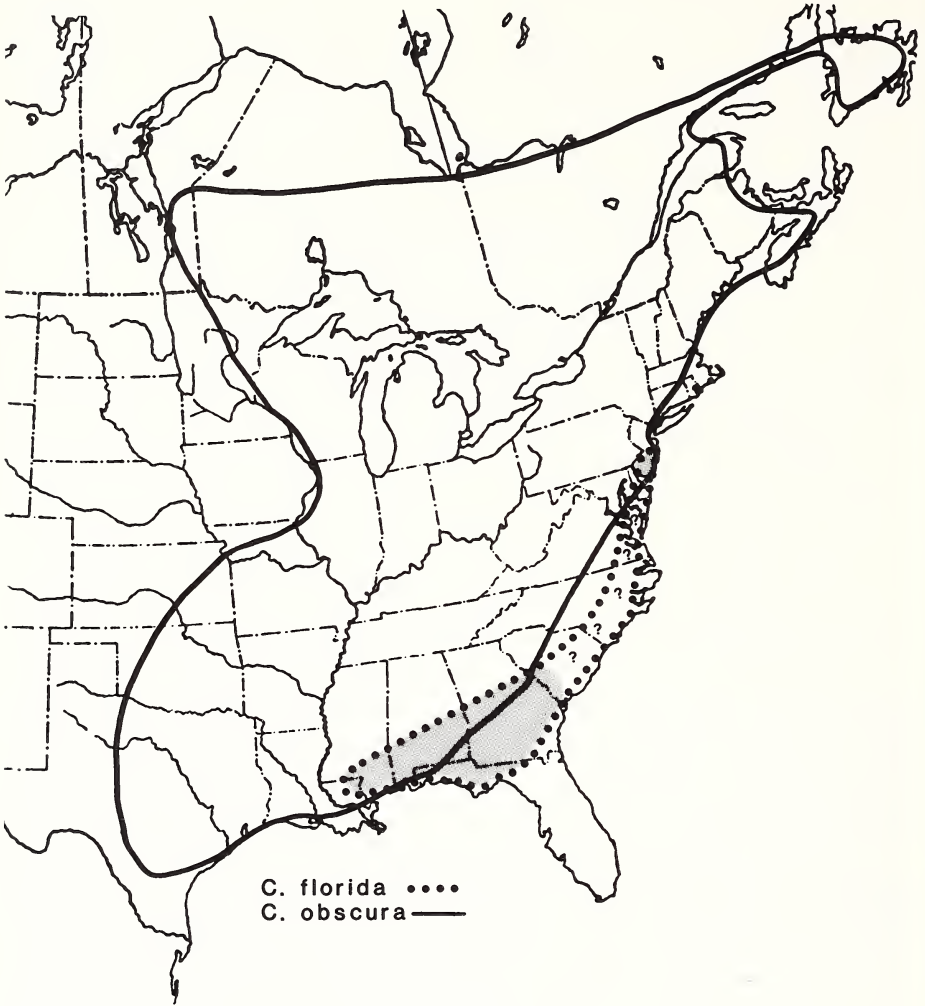


Fig. 13. Distribution of *C. obscura* and *C. florida*.

possess a ventro-mesal accessory spine at the point where the apices curve upward (Fig. 8D). In *socia* the tips of these rods usually project toward one another at about a 45° angle in caudal view, whereas the apices of these rods in *parasocia* are elongate and project directly dorsad, lying parallel to each other in caudal view. Additionally, in lateral view the dorsal arm of the inferior appendages is nearly parallel sided and has only a slightly enlarged apex in *socia*; whereas, in *parasocia* the main shaft of the dorsal arm appears more or less constricted and the apical region is expanded caudally (Fig. 8A).

Variation within the specimens examined involves the degree of development of

the accessory spine on the dorsal aedeagal rods and the width of the inferior appendages. In one specimen from Louisiana and a small series from Columbus, Mississippi, the accessory spines are very small and hardly noticeable. One specimen from Montgomery County, Arkansas had no accessory spines, but was like *parasocia* in all other respects. The specimen of *socia* reported from Pineville, Kentucky, by Resh (1975) is *parasocia*. H. H. Ross had originally identified the specimen as *socia* and included a note with the specimen stating "atypical claspers and aedeagus."

*Distribution.* Southeastern Kentucky and southern Missouri south to the Gulf Coast in eastern Louisiana and Alabama (Fig. 14).

*Etymology.* The specific epithet, *parasocia*, refers to the close resemblance of this species to *C. socia*.

*Chimarra socia* Hagen

Figs. 9, 14

*Chimarra socia* Hagen, 1861:297; Ross, 1944:51.

*Womaldia femoralis* Banks, 1911:358; Milne, 1936:82 (as syn. of *Chimarra socia*).

The genitalia of *socia* (Fig. 9) are generally similar to those of both *parasocia* and *moselyi*. Specimens can be identified as indicated in the discussion of *parasocia*.

Variation is primarily seen in the shape of the dorsal aedeagal rods. Most specimens have these rods as in Figure 9C, but in some from Minnesota the tips of the rods curve directly mesad, thus they appear to be flat in lateral view. In some Canadian specimens, the rods are more sinuate than those illustrated here and the upturned apex appears to be longer; however, the tips of the rods converge in caudal view and do not approach the parallel arrangement seen in *parasocia*.

*Distribution.* *Chimarra socia* is almost entirely restricted to the Northeast occurring southward only in the Appalachian Mountains (Fig. 14). Because of the confusion of *socia* with *parasocia*, most records for the former from the southeastern states are properly applied to the latter. States from which *socia* has been correctly reported are: Maine, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Virginia, West Virginia and Wisconsin. We also examined specimens from eastern Tennessee.

*Chimarra moselyi* Denning

Figs. 10, 14

*Chimarra moselyi* Denning, 1947:251.

*Chimarra perigua* Ross, 1948:24-25; Denning, 1950:45 (as syn. of *C. moselyi*).

The angulate ventral aedeagal rods (Fig. 10C) are sufficient for separating members of this species from the two preceding species. Other distinctive characters of the genitalia (Fig. 10) are outlined in the discussion of *parasocia*.

Slight variation in the position of the ventral aedeagal rods was observed. The bases of the rods may be close together (Fig. 10D), or they may be separated, leaving only the angulations approximate, the overall effect being an X-like configuration (cf. Ross, 1948, fig. 7). Of the *Chimarra* species we studied, this species was one of the least variable.



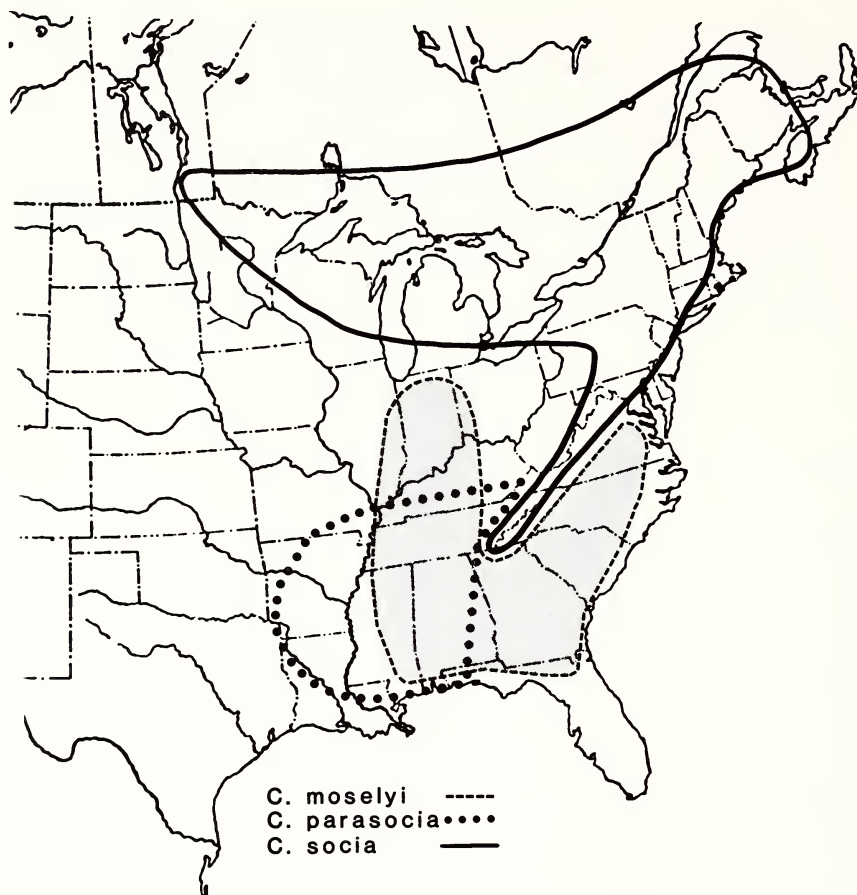


Fig. 14. Distribution of *C. socia*, *C. parasocia* and *C. moselyi*.

*Distribution.* Eastern Illinois and northern Indiana; south to the Gulf Coast in eastern Louisiana, northern Florida, and north through the Atlantic states into Virginia (Fig. 14). Apparently absent from the Appalachian Mountains proper. Specimens of *moselyi* from Alabama, Florida, Georgia, Illinois, Indiana, Mississippi, Missouri, South Carolina and Virginia were examined.

#### PHYLOGENY OF THE EASTERN SPECIES OF *CHIMARRA*

Phylogeny and dispersal of the major groups within the genus *Chimarra* were discussed by Ross (1956), and he considered the *aterrima* group of the Americas to be descendant from a *C. digitata* type ancestor (Southeast Asia). A phylogeny for the species treated here is shown in Figure 15.

Monophyly of the *aterrima* group is indicated by the following synapomorphies (Ross, 1956):

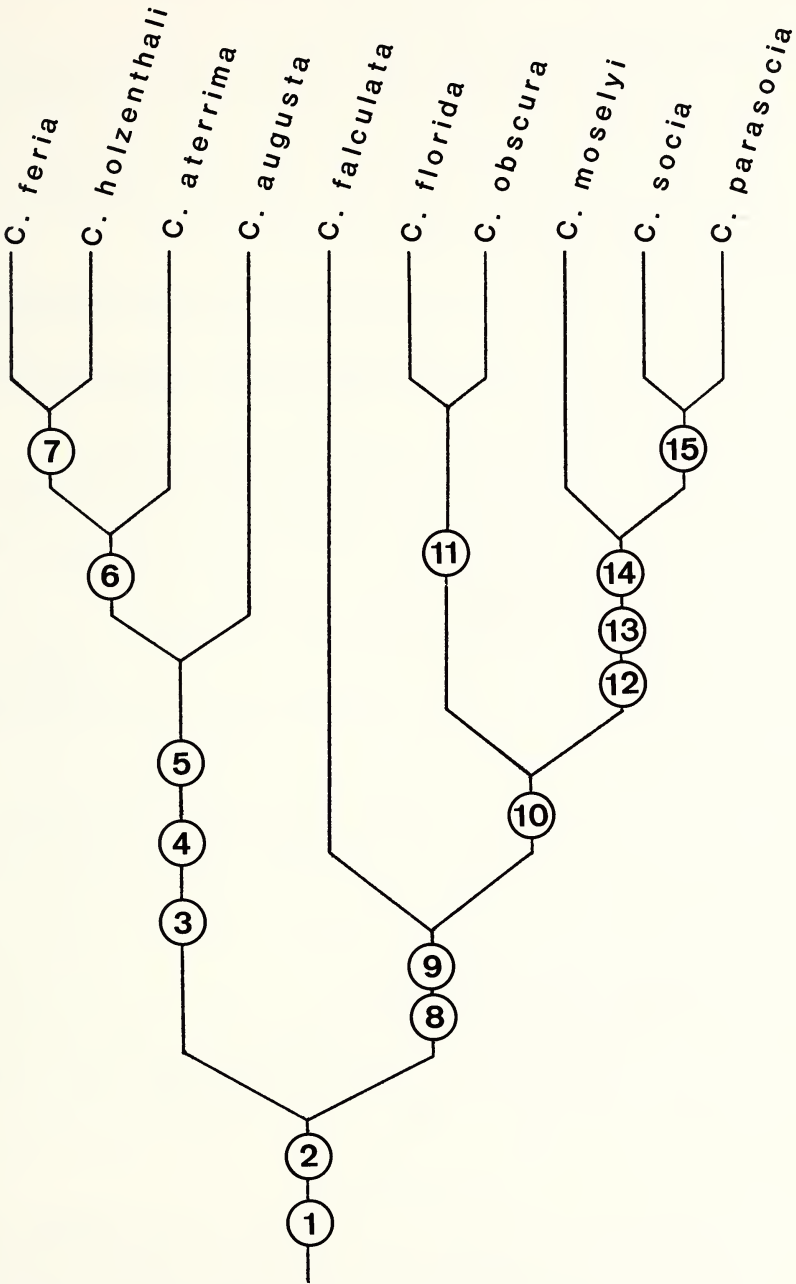


Fig. 15. Phylogeny of the *Chimarra* of eastern North America.

1. Tergum X membranous, divided apically.
2. Intermediate appendage with two dorsal sensilla.

Members of the *aterrima* complex (*aterrima*, *augusta*, *feria* and *holzentali*) share the following apomorphies:

3. Inferior appendage with long dorso-mesal and short mesal processes.
4. Intermediate appendage with sinuate, twisted and elongate dorso-lateral ridge, ridge with subapico-dorsal projection and broad mid-region.
5. Phallic rods asymmetrical.

All of the *aterrima* complex, except *augusta*, share the following apomorphic character:

6. Dorso-mesal process of inferior appendage longer (as compared to the condition seen in *augusta*).

Monophyly of *feria* and *holzentali* is inferred by one synapomorphy:

7. Inferior appendage with dorso-lateral shoulder and concave dorsal margin.

Members of the *obscura* complex (*falculata*, *florida*, *moselyi*, *obscura*, *parasocia* and *socia*) share the following apomorphies:

8. Apex of ventral wall of phallus extended, free from membranes.
9. Inferior appendages elongate dorsally.

All species in the *obscura* complex, except *falculata*, share the following apomorphic character:

10. Apex of the ventral wall of the phallus slightly curved ventrad.

Monophyly of *florida* and *obscura* is inferred by the following synapomorphy:

11. Apex of the ventral wall of the phallus strongly curved ventrad and enlarged.

Three synapomorphies indicate monophyly of *moselyi*, *parasocia* and *socia*:

12. Intermediate appendage spatulate.
13. Transverse ridge of sternum VIII absent.
14. Ventral process of segment IX spatulate.

*Chimarra parasocia* and *socia* share the following synapomorphy:

15. Apex of inferior appendage with heavily sclerotized point.

#### ACKNOWLEDGMENTS

We wish to thank Dr. John C. Morse and Dr. Oliver S. Flint, Jr. for their comments on an earlier draft of this manuscript. Additionally we are indebted to Dr. Morse for his assistance with the phylogenetic analysis. The Geological Survey of Alabama provided facilities and support for the junior author during this study. Ruth Turner photographed many of the plates. Our thanks to Jane Ratliff, Department of Biology, The University of Mississippi, for typing this manuscript.

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**ZAPADA KATAHDIN, A NEW STONEFLY  
(PLECOPTERA: NEMOURIDAE) FROM THE NORTHEAST**

RICHARD W. BAUMANN AND TERRY M. MINGO

Department of Zoology, Brigham Young University,  
Provo, Utah 84602, and

Department of Entomology, University of Maine,  
Orono, Maine 04469

*Abstract.*—*Zapada katahdin*, n. sp. male, female and nymph are described from Baxter State Park, Maine. Descriptions are enhanced by original drawings. Paratypes are recorded from Maine, New Hampshire and Quebec. *Zapada katahdin*, n. sp. is univoltine and emerges during late April. Nymphs were collected only from cold, permanent streams and appear to be restricted to the headwater regions.

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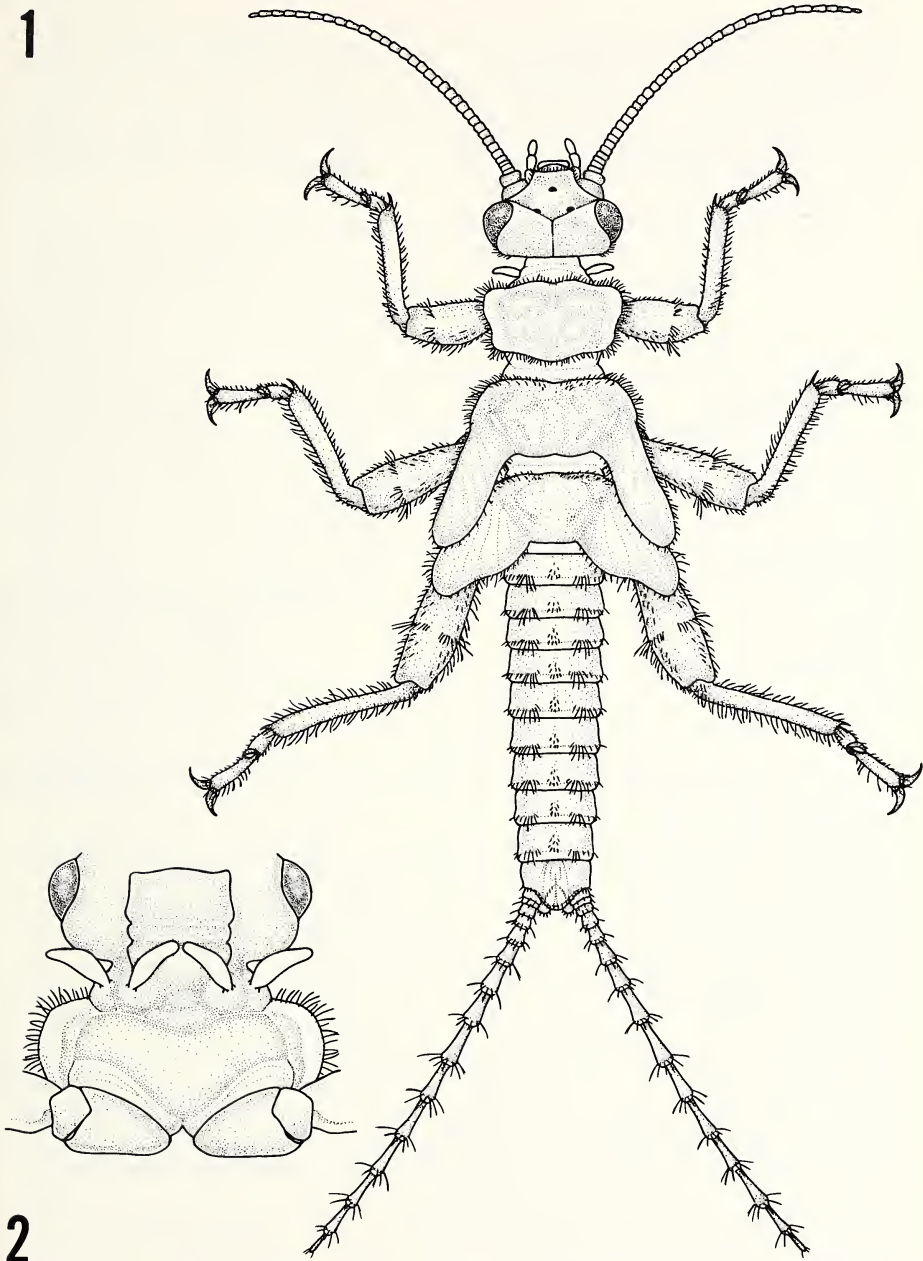
***Zapada katahdin*, new species**

Figs. 1-9

*Diagnosis.* This species is similar to *Z. haysi* (Ricker) and *Z. oregonensis* (Claassen) but can be separated consistently by characteristics of the male genitalia. Male epiproctal differences: *Z. oregonensis* with large sclerotized projections extending ventrally from lateral arms, midway between apex and curve; *Z. katahdin* with broad sclerotized portion of lateral arms ending before curve and not extending down toward apex as in *Z. haysi*.

*Description.* Nymph: Length of mature male 7.0-8.0 mm; mature female 8.0-10.0 mm. Pronotum nearly square, slightly wider at anterior margin, bearing fringe of stout spines of nearly equal length. Cervical area with four single gills, two on each side of midline, gills sausage shaped, constricted at base, approximately six times as long as wide at broadest point (Figs. 1, 2).

Male macropterous. Length of forewings 7.0-8.0 mm; length of body 6.0-7.0 mm. General color brown. Legs with darker pigmented areas on coxa, trochanter, tarsi and at junction of femur and tibia. Wings hyaline; forewings with large dark areas at cord and at apex, separated by broad light band. Ninth sternum bearing short broad vesicle, hypoproct narrow at base, expanding laterally to angular points and anterior of vesicle, apex tapering to pointed tip (Fig. 5). Paraprocts with two sclerotized lobes: inner lobe short and thin, outer lobe broad and nearly square (Fig. 5). Epiproct recurved, mostly membranous; dorsal sclerite large at base, extending from midline to lateral margins, narrowing toward apex, curving along lateral margins, producing open area at apex (Fig. 7); lateral arms short, moderately wide and sclerotized (Fig. 6a); ventral sclerite broad at base, becoming narrow most of length, almost enclosed by dorsal sclerite along apical-lateral margins, bearing 13-15 stout spines laterally, spines arranged in irregular rows (Fig. 6b); basal sclerites formed into elongate triangles. Tenth tergum with concave indentation medially, apex of indentation lightly sclerotized and forming small light triangular shaped area under apex of epiproct (Figs. 3-5).



Figs. 1, 2. *Zapada katahdin*. 1. Nymph, habitus. 2. Prosternum and head, ventral, showing cervical gills.

Female macropterous. Length of forewings 9.0–10.0 mm; length of body 7.0–9.0 mm. Body, appendages and wings similar to male. Body proportions generally more robust in females. Subgenital plate well developed, posterior margin of seventh sternum expanded over most of eighth sternum, plate broadly rounded, slightly truncate apically, expanded portion more darkly sclerotized (Fig. 8). Eighth sternum excavated medially, excavated area lightly sclerotized, except for thin darkly sclerotized band over genital opening.

*Holotype*. ♂. MAINE: Penobscot Co., Katahdin Stream, Baxter State Park, 24 April 1980, T. M. Mingo (deposited at USNM).

*Paratypes*. NEW HAMPSHIRE: Coos Co., Tuckermans Ravine, Mt. Washington, 23 June 1941, T. H. Frison and H. H. Ross, 1♀ (INHS). MAINE: Penobscot Co., same data as holotype, 6♂♂ (BYU, UM, USNM, WER); Abol Stream, 1 mile above Abol Falls, Baxter State Park, 24 April 1980, T. M. Mingo, 2♂♂, 10♀♀ (includes allotype female), some specimens were collected as nymphs and emerged in the laboratory between 24 April and 30 April 1980. QUEBEC: Ungava, Koksoak River, 17 June 1966, J. B. Coleman, 2♀♀ (BYU).

*Additional material examined (nymphs)*. LABRADOR: Secret Brook, August 1974, C. F. Rabeni (UM). MAINE: Penobscot Co., Katahdin Stream, above Katahdin Stream campground, Baxter State Park, 23 September 1978, T. M. Mingo (UM); Katahdin Stream at Katahdin Falls, Baxter State Park, 26 October 1979, T. M. Mingo (UM); Abol Stream, 1 mile above Abol Falls, Baxter State Park, 14 April 1980, T. M. Mingo (BYU, UM, USNM).

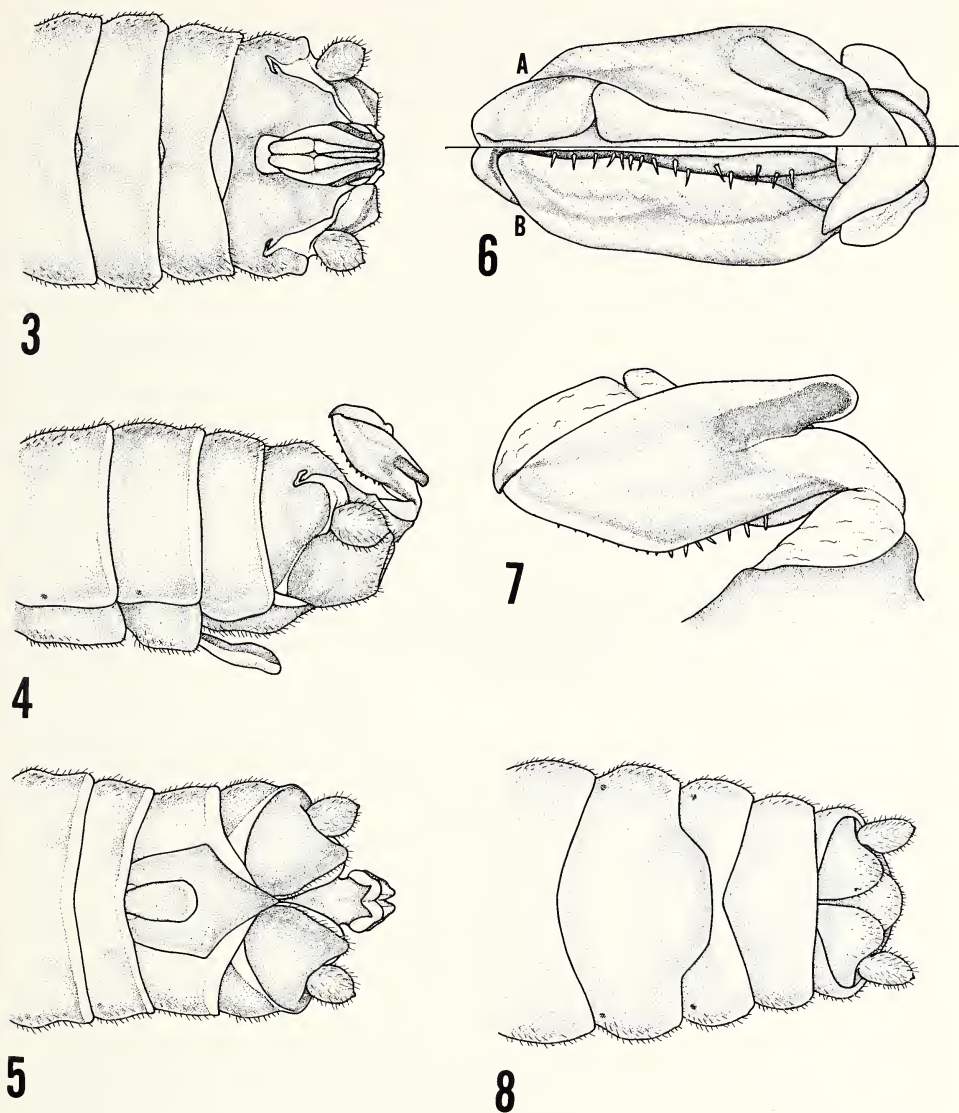
*Etymology*. The species name is derived from Mt. Katahdin, Maine, the type locality of this stonefly. The name "Katahdin" is an English condensation of the Abnaki Indian words "keght" which means "principal" and "adene" which means a "mountain" (Eckstorm, 1941). Mt. Katahdin, the highest elevation in the state, is a glacial peak that rises abruptly to 5,267 feet from the surrounding terrain in north central Maine.

*Biology*. The life cycle and seasonal distribution of *Z. katahdin* are shown in Figure 9. The species is univoltine with the nymphal stage lasting approximately twelve months. Early instar nymphs were first collected in late April and early May. Growth is continuous during the spring, summer and fall and maximum growth is attained by late October. *Zapada katahdin* overwinters as mature or nearly mature nymphs and adults emerge the following spring in late April. When adults emerge water temperatures are near 0°C and snow and ice still persist along the stream banks.

The distribution and abundance of nymphs collected from the Mt. Katahdin streams, suggests that specimens in this area represent an isolated, remnant arctic population. Nymphs were collected only from cold, permanent streams and seemed to be restricted to the headwater regions. Nymphal abundance increased markedly toward the headwaters, particularly at elevations  $\geq 1,800$  feet. Individual specimens were collected at lower elevations ( $\geq 1,000$  feet), however, these were uncommon and probably represented drifting individuals. The maximum water temperature for Katahdin Stream on 24 July was 15°C and it was 18°C for Abol Stream, on 24 July.

A single nymphal specimen belonging to this genus was collected from Avalanche Brook, Baxter State Park, Maine on 22 August. Water temperature was not recorded.

*Discussion*. Ricker (1952), in his revision of the North American Nemouridae,



Figs. 3–8. *Zapada katahdin*. 3. Male terminalia, dorsal. 4. Male terminalia, lateral. 5. Male terminalia, ventral. 6. Epiproct: a, dorsal; b, ventral. 7. Epiproct, lateral. 8. Female terminalia, ventral.



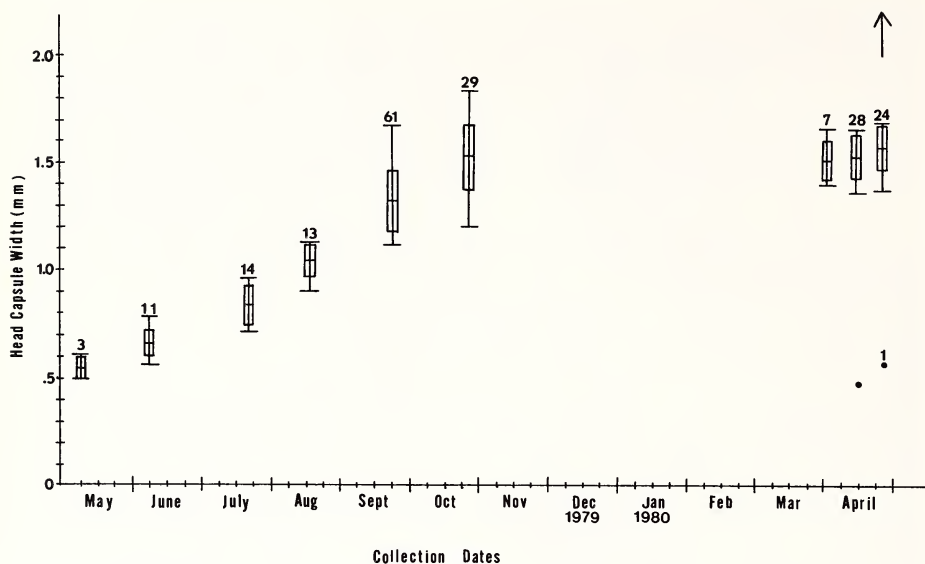


Fig. 9. Life cycle and seasonal distribution of *Z. katahdin*, n. sp. in Baxter State Park, Maine (combined data from Katahdin Stream and Abol Stream). Bars represent mean, standard deviation and range of head capsule widths for each sample period. Number above bar represents sample size and arrow indicates adult emergence.

described *Zapada chila* from Great Smoky Mountains National Park and published the first report of a *Zapada* specimen from northeastern North America. His report was based on a single female specimen collected at Tuckermans Ravine, a protected glacial cirque on the eastern slope of Mt. Washington, New Hampshire, on 23 June 1941, by T. H. Frison and H. H. Ross. The specimen was at first thought to belong to the western species *Zapada oregonensis* (Claassen) (Ricker, 1952; Hitchcock, 1969) but was later believed to be allied to, or possibly the same as, another western species *Zapada haysi* (Ricker) (Ricker et al., 1968; Hitchcock, 1974). The specimen was re-examined by Baumann and Gaufin (1971) and found not to belong to any known species.

Additional *Zapada* specimens have been reported from eastern Canada (Ricker et al., 1968; Harper and Hynes, 1971) and from the northeastern United States (Mingo, 1983), however, a final decision concerning their identity cannot be made until males have been studied.

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The authors wish to thank the following individuals who provided specimens or otherwise participated in the search for this interesting stonefly species: John R. Coleman, Ontario Ministry of Natural Resources; Peter P. Harper, University of Montreal; William E. Ricker, Nanaimo, British Columbia; and the late Herbert H. Ross, then at the Illinois Natural History Survey. The drawings were made by Jean A. Stanger.

Collections cited in text are abbreviated as follows: BYU—Brigham Young University, Provo, Utah; INHS—Illinois Natural History Survey, Champaign, Illinois; UM—University of Maine, Orono, Maine; USNM—National Museum of Natural History, Washington, D.C.; WER—William E. Ricker, Nanaimo, British Columbia, Canada.

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**BIOLOGY OF THE MYRMECOMORPHIC PLANT BUG  
*COQUILLETIA INSIGNIS* UHLER  
(HETEROPTERA: MIRIDAE: PHYLINAE)**

JAMES D. McIVER AND GARY M. STONEDAHL

Systematic Entomology Laboratory, Oregon State University,  
Corvallis, Oregon 97331, and  
Department of Entomology, American Museum of Natural History,  
Central Park West at 79th Street, New York, New York 10024

*Abstract.*—The basic biology of *Coquillettia insignis* Uhler (Heteroptera: Miridae: Phylinae) is described, including details of its growth, morphology, phenology, behavior and ecology. The distribution and abundance of this species over 20 sites in an eastern Oregon valley was studied, as well as its temporal and spatial relation to its host plant *Lupinus caudatus* Kell. Twelve species of ants were collected on *L. caudatus* of which six species were common; temporal, behavioral and morphological correspondence of these six species to various stadia of *C. insignis* are described. We identify several species of vertebrate and visual arthropod predators that could potentially serve as operators in the Batesian mimicry system to which *C. insignis* probably belongs.

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*Coquillettia insignis* Uhler (Miridae: Phylinae) is a highly myrmecomorphic (ant-like) plant bug traditionally recognized as belonging to the tribe Hallodapini. This predominantly Old World tribe is comprised entirely of ant-like species and contains some of the most convincing morphological and behavioral 'mimics' of ants. With the exception of *Cyrtopeltocoris* Reuter, the New World genera of the tribe (*Coquillettia* Uhler, *Orectoderus* Uhler, *Teleorhinus* Uhler) and the Palearctic genus *Ethelastia* Reuter are now considered to form a monophyletic group distinct from other hallodapines (R. T. Schuh, pers. comm.). The less ant-like genus *Pronotoceprepis* Knight also seems to belong to this group, although its current placement is in the tribe Phylini (Carvalho, 1958).

*Coquillettia* is a North American genus comprising 22 species, all of which have females with remarkably ant-like appearance. Many species are very similar in external morphology and general coloration, making species recognition difficult. The lack of a comprehensive comparative study of the genus compounds the difficulty in obtaining accurate species identifications. Our determination of *C. insignis* for the present study was based on an examination of type specimens at the National Museum of Natural History, Washington, D.C. Although our study material was most representative of the type of *insignis*, we recognize that this species is highly variable as currently known, and that a careful comparative study of *insignis* and related species may alter the existing classification and nomenclature of the group. From our study of museum specimens and literature records (Carvalho, 1958 and included references; Kelton, 1980), it is evident that *insignis* is widely distributed in western North America (Fig. 1). It is typically associated with plants of the genus *Lupinus* L., but also has been reported (by label data) feeding on *Astragalus* L. and *Oxytropis* DC.

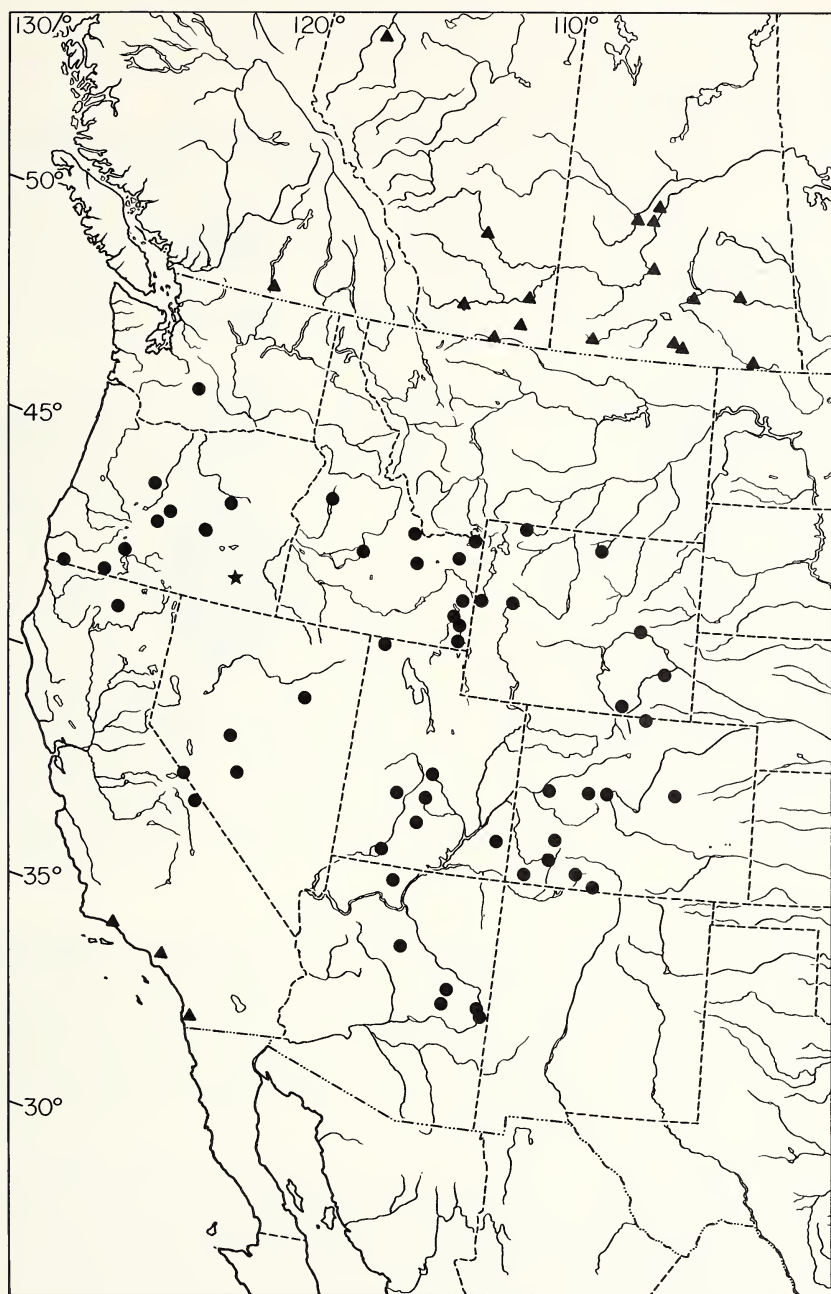


Fig. 1. Distribution of *Coquillettia insignis* Uhlér: ●, records from our examination of museum specimens; ▲, other published records (also reported from the Dakotas, Kansas, Montana, and Texas but with no specific locality data); ★, Pike Creek study area in southeastern Oregon.



(other Fabaceae) in Colorado and Wyoming. In the Great Basin, adults are sometimes collected on sagebrush (*Artemisia* spp.).

The adults of *insignis* are sexually dimorphic, with the female being totally apterous and strongly ant-like (Fig. 2). The major myrmecomorphic features of the female include: 1) aptery; 2) elongation and lateral rounding of the thoracic tergites, especially the pronotum; 3) bulbous, petiolate abdomen with the anterior three segments strongly constricted and the lateral margins (connexiva) abruptly upturned; 4) large, elongate head with greatly enlarged gular region (Fig. 3); and 5) long, narrow legs. The adult male is macropterous and much less ant-like (Fig. 4), lacking all of the thoracic and abdominal modifications of the female, except the weakly constricted anterior abdominal segments.

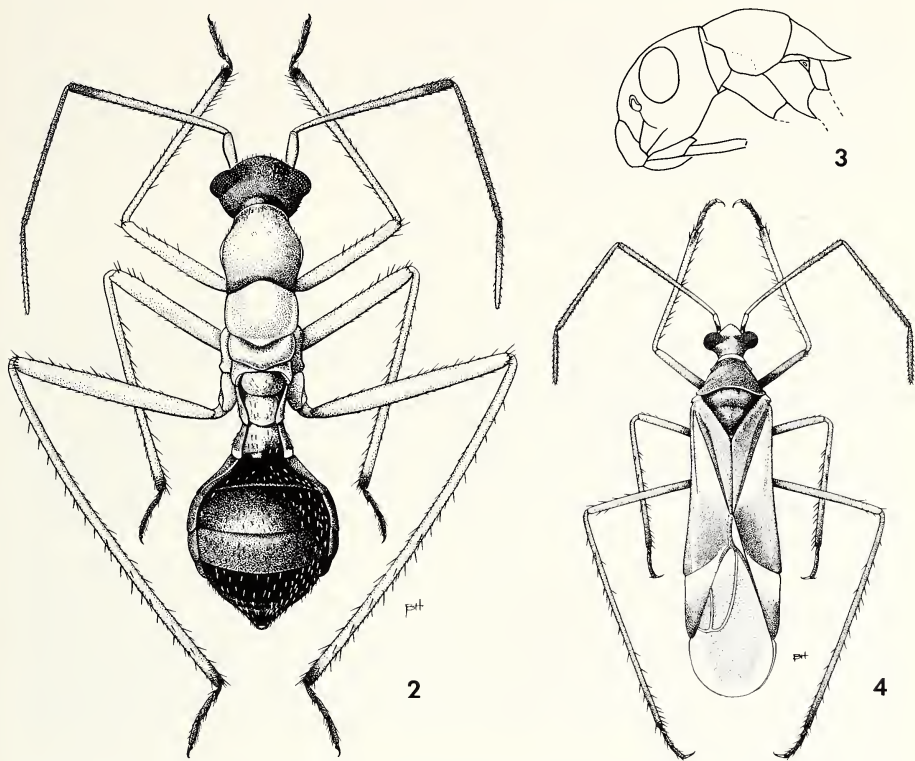
The nymphs of both sexes are good myrmecomorphs (Fig. 5), exhibiting many of the morphological attributes seen in the adult female. Late instar males are somewhat less ant-like due to growth of the meso- and metathoracic wing pads. Nymphs and adults of *insignis* have a pale, transverse band on the posterior margin of abdominal tergite III (both ventral and lateral surfaces) that may serve to enhance the petiolate appearance of the abdomen.

Although *Coquillettia* species are among the most convincing of myrmecomorphic insects, details on their basic biology and ecological relation to ant models and to potential operators are virtually unknown. *Coquillettia insignis* is an ideal candidate for the study of ant-mimicry because it is easy to sample, easy to maintain in the laboratory, and is relatively host-specific on lupine, allowing accurate identification of the arthropod community within which it interacts. This paper describes the basic biology of *insignis* and identifies the common arthropod species associated with it, including ant models and potential operators. This study, in conjunction with a similar treatment of *Orectoderus obliquus* Uhler (McIver and Stonedahl, 1987), will serve as a base upon which more detailed studies of ant-mimicry will depend.

#### METHODS AND MATERIALS

*Study area.* The research was conducted in June 1984 and May through August 1985 on the east escarpment of Steens Mt. in southeastern Oregon (118°32'30"W; 42°32'30"N). *Coquillettia* populations were studied at 20 sites along an altitudinal gradient from 1,353 m to 2,286 m (4,400–7,500 ft), within the Pike Creek drainage system. From these 20 sites, five primary sites were selected for intensive study (GBL, GBH, PLAT, CONF, HILL) (Fig. 6). Most of the specimens used for various aspects of the study were taken from these five sites.

Although varying in altitude (1,577–1,775 m), aspect (ESE-facing to SSW-facing) and slope (0° to 40°), plant communities of all primary sites were similarly dominated by sagebrush (*Artemisia tridentata* Nutt.), rabbitbrush (*Chrysothamnus nauseosus* (Pall.) Britton) and greasewood (*Sarcobatus vermiculatus* (Hook) Torr.), with a variety of herbaceous species intermixed (Great Basin Province, after Franklin and Dyrness, 1973). Since *C. insignis* was typically found only on *Lupinus caudatus* Kell., we focused our attention on this widely distributed species of erect, perennial, small-flowered lupine. The selection of study sites and the duration of the study allowed us to examine *Coquillettia* biology over its entire range within the Pike Creek drainage and over the entire active portion of its life cycle.



Figs. 2-4. Adults of *C. insignis*. 2. Female, dorsal habitus. 3. Female, lateral view of head. 4. Male, dorsal habitus.

**Methods.** Individuals representing all active stages of *Coquillettia* were collected in the field for description and illustrations. Some of these were reared on a lupine diet to obtain estimates of instar duration at ambient field temperatures (1-25 June 1985). Since temperature patterns throughout June were fairly constant (range of highs: 25°-32°C; range of lows: 8°-14°C), the instar duration estimates are good relative indicators of stage longevity. Eighteen field-collected and ten laboratory-reared females were dissected to obtain estimates of fecundity.

Sustained field observations were made of *Coquillettia* behavior on its host plant. Observations of continuous behavior were dictated onto a cassette tape recorder, and time budgets constructed for each set of observations. Casual observations of behavior were made throughout the season to supplement the time budget data. We observed behavioral activity for 3rd, 4th, and 5th instar nymphs, as well as for both sexes of adults. These data were compared with similar observations made on *Orectoderus obliquus* Uhler (another myrmecomorphic hallodapine) and *Lopidea* nr. *rolfsi* Knight, a nonmimetic plant bug.

Distribution of *C. insignis* was examined on a geographic scale (using information from the literature and museum collections), over the twenty Pike Creek sites, and

among individual plants at each primary site. Local dispersion patterns are described for the within-site data among individual plants.

Relative abundance, expressed as frequency per plant, was compared over primary sites (on each sample date) and within sites over time. Each sample consisted of five 50-sweep subsamples representing approximately 25 lupine plants. From these data we calculated a 'deme development index'—

$$\left( \sum_{i=1}^6 n_i \cdot i \right) / N,$$

where  $i$  = instar;  $n_i$  = # individuals at stage  $i$ ;  $N$  = total # individuals—starting at population peak and running through the remainder of the season for each of the five primary sites. This index provided an indication of the effect of elevation on the initiation and speed of postembryonic development in *insignis*.

The phenology of *L. caudatus* was monitored by recording size, condition, and degree of development for a set of lupine plants at the HILL, CONF, and GBH sites through June and early July 1985. This information allowed us to make inferences on the extent to which *Coquillettia* individuals distribute themselves according to these three plant properties.

At 5-day intervals from 1 June through 3 July 1985 (peak *Coquillettia* season), sweep-net and beat-sheet samples were taken from lupine at the CONF and PLAT sites to identify co-occurring ant species and the arthropod predator fauna. A list of possible avian and lizard predators observed foraging on lupine was also made. This information on potential models (ants) and operators (visual predators) is necessary for further studies on the nature of the tripartite Batesian mimicry system to which *Coquillettia* may belong.

#### RESULTS AND DISCUSSION

*The life cycle.* Overwintered eggs of *insignis* begin hatching in early to mid-May (at about 1,525 m elevation), and first instar nymphs can be found in the field until about the third week of June. Despite this wide temporal range in eclosion, most eggs hatch within a 10-day period in late May and early June. All nymphal instars of *insignis* are active, feeding stages. The durations of the five nymphal stadia, as determined by laboratory rearing, averaged 4.25, 5.12, 6.67, 6.05, and 7.71 days, respectively (Table 1). Total developmental time from first instar to adult averaged 29.86 days. Only field-collected specimens that appeared newly eclosed were used to determine stadium duration for the first instar nymph. Temporal range and peak abundance of nymphal and adult stages show *insignis* to be a 'June' species.

The phenology of *Coquillettia* tends to coincide with that of its host plant, *L. caudatus* (Fig. 7), which undergoes substantial vegetative growth starting in late April and continuing through May and early June. By early June (beginning of peak *Coquillettia* season), over 50% of the available lupine plants at GBL had flowered, while fewer than 10% had set seed. By 10 June, 74% of all plants at the same site had flowered or set seed and by 17 June, 90% had flowered or set seed. Plants decline in condition after the third week in June, with 100% of the individuals senescent at the lower sites (GBL, GBH, PLAT) by 6 July. *Coquillettia* tends to be associated with



Table 1. Duration (in days) of the nymphal instars of *C. insignis*.

Instar	N	Days		
		Range	$\bar{x} \pm SE$	Cum. mean age
1st	2	4.0, 4.5	4.25	4.25
2nd	4	4.5–5.5	$5.12 \pm 0.25$	9.43
3rd	6	3.0–11.0	$6.67 \pm 1.15$	16.10
4th	19	3.5–11.0	$6.05 \pm 0.51$	22.15
5th	21	4.0–11.0	$7.71 \pm 0.40$	29.86

plants of younger than average age, greater than average size, and better than average condition (McIver, pers. obs.). These observations of association between *Coquillettia* and *L. caudatus* suggest that *Coquillettia* individuals discriminate between plants of variable quality, an observation consistent with its herbaceous habit.

Whereas males disappear by the third week in July, females continue ovipositing until the second week in August. Ovipositional behavior was observed only once in the laboratory, with a female depositing eggs under the outer woody layer of a sagebrush stem. The female probed with her proboscis for several minutes at a single spot on the stem and then brought the ovipositor down on the probed area. The ovipositor was then gradually worked into the stem by flexing the entire abdomen along the longitudinal axis and by flexing the ovipositional muscles. The rear legs were suspended in the air during this process. When the ovipositor was embedded in the stem to within 1 mm of its base, the female stopped movements for 10 to 12 seconds and then quickly withdrew. Although this behavior was repeated three times, it is unlikely that *insignis* oviposits on sage in the field, as females are rarely collected on *Artemisia*. The preferred oviposition sites are probably the dried out, persistent lupine stems, a habit consistent with that observed for *O. obliquus* (McIver and Stonedahl, 1987). Eggs overwinter under the outer layer of dried stem tissue, and nymphs emerge in mid-May to early June to complete the life cycle. Whether *insignis* enters diapause is not known.

**Fecundity estimate.** A total of 28 adult females were dissected to determine egg load. Ten of these were reared from 5th instars and were dissected as virgins 2 days after the final molt. Average number of eggs for these females was  $12.1 \pm 2.7$  (95% conf. interval), ranging from 7 to 20. Average egg load for 18 field-collected females was  $14.7 \pm 2.2$ , with a range from 10 to 30. All eggs dissected from mature females were relatively large (1.0–1.3 mm) and appeared in most cases to be fully developed. The egg load usually occupied the entire bulbous portion of the abdomen and was especially tightly packed into the dorsal half of the abdominal cavity. Given the large volume of the egg load and the similar stage of development of all eggs in the ovaries, it is likely that *Coquillettia* produces only a single cohort of eggs, which are laid over a 4–6-week period. If this is the case, then our determination of egg load should be an accurate estimate of total fecundity. However, we have no conclusive evidence that *Coquillettia* does not develop subsequent cohorts of eggs.

**Description of immature stages.** EGG (Fig. 5a). Length 1.30–1.50 (all measurements are in millimeters), greatest width 0.19–0.22; gently curved with weakly constricted



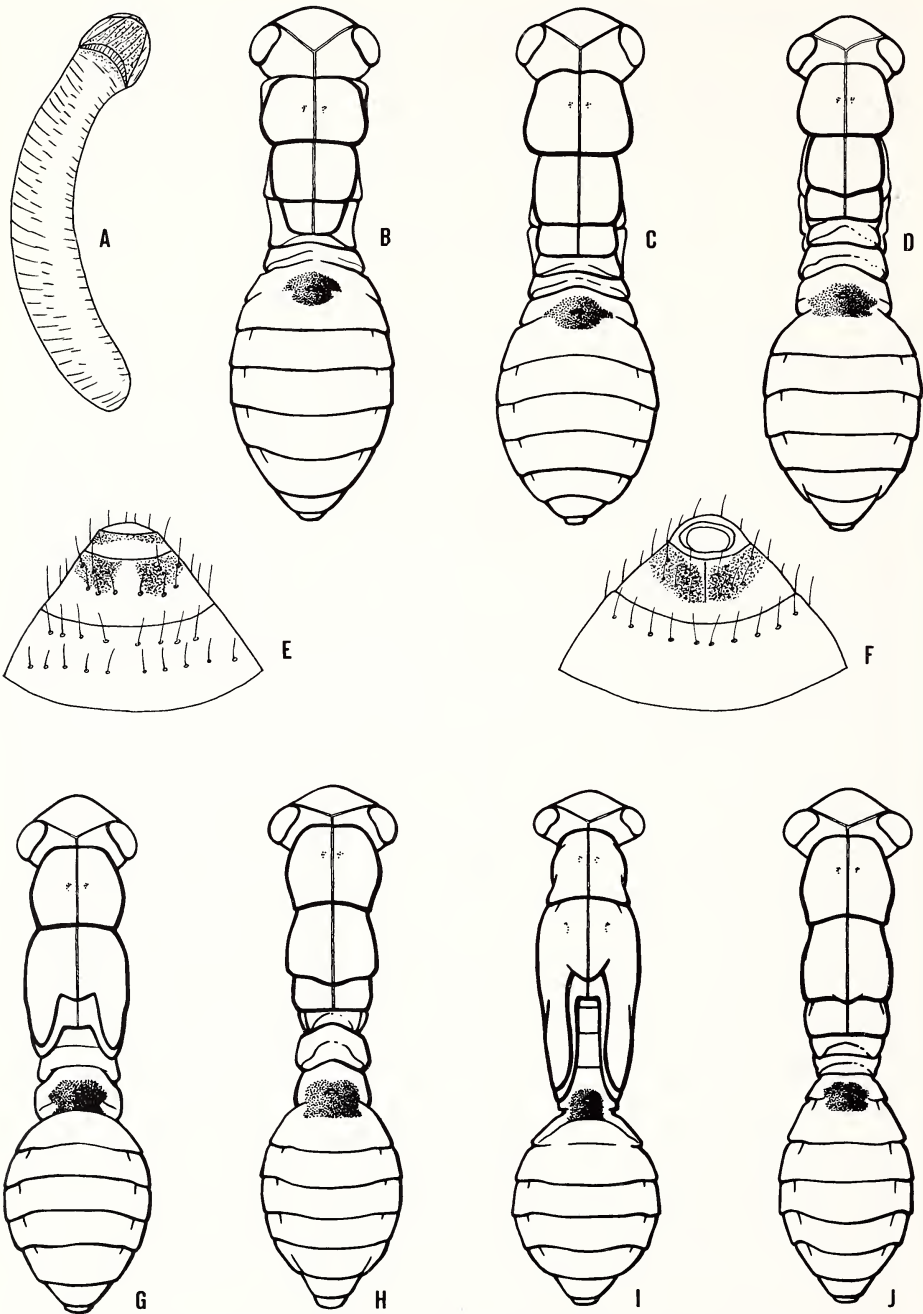


Fig. 5. Immature stages of *C. insignis*. a. Egg. b. First instar. c. Second instar. d-f. Third instar. d. Dorsal habitus. e. Ninth sternite of male. f. Ninth sternite of female. g, h. Fourth instar. g. Male. h. Female. i, j. Fifth instar. i. Male. j. Female.

neck; grayish white or pale brownish yellow; surface of corium smooth; anterior pole with simple, weakly convex chorionic operculum and large, distally tapered opercular process, both enclosed by thin chorionic rim collar.

**NYMPHS** (Fig. 5b–j). The body regions of *insignis* nymphs are in large part weakly sclerotized. This is especially true of younger instars and of the abdomen of all stages. As a result, there is noticeable variation in the size and shape of the body, even between specimens of the same age. Abdomen shape is strongly influenced by the volume of food consumed and the length of time between feeding bouts. In illustrating the nymphs of *C. insignis*, we have selected alcohol-preserved specimens of average size and general shape, with no noticeable distortion of the various body regions. The five nymphal instars (see following descriptions) are most easily differentiated by overall length, size of the head capsule, length of the rostrum and second antennal segment, and for 3rd–5th instar males, the size of the wing pads (see Appendix 1 for comparative measurements). Sex can be determined down to the third instar by differential development of the sclerotized plates on the ninth abdominal sternite (Fig. 5e, f) and by the development of wing pads in the male.

**FIRST INSTAR** (Fig. 5b). Length 1.31–1.70 (measured from tip of tylus to apex of abdomen in lateral view; see Appendix 1 for other measurements); strongly myrmecomorphic, brown or reddish brown general coloration; abdomen pale, only lightly tinged with brown; head and thoracic nota shining, finely granulate; dorsum with sparsely distributed, short, black, bristle-like setae; antennae and legs with more densely distributed dark setae. Head: large, strongly declivous, subovate in lateral view, triangulate in frontal view; vertex strongly convex, posterior margin indistinct; frons weakly convex, strongly slanting anteriorly to weakly depressed junction with tylus; antennal fossa large, situated well anterior of eye; tylus short, moderately produced; jugum, lorum, and buccula short; gena and gula broad. Rostrum: reaching between metacoxae; segments I–IV similar in length. Antennae: brown, segment IV sometimes tinged with red; segment I short, barrel-shaped, slightly broader than II–IV; segments II and III linear, similar in length; segment IV slightly longer than II and III, tapered distally to narrowly rounded apex. Thorax: uniformly brown or dark brown; nota quadrate, pronotum slightly larger than mesonotum, these much larger than metanotum; pronotum with broadly rounded angles, lateral margins slightly sinuate, anterior margin weakly convex, posterior margin weakly concave; calli indistinct; meso- and metathoracic wing pads not developed. Abdomen: oblong-ovate, bulbous, segments I–III noticeably constricted; translucent, pale yellow or creamy white, sometimes lightly tinged with red; weakly sclerotized except for small sub-spherical disk surrounding external pore of dorsal abdominal scent gland (pore situated medially on suture between abdominal tergites III and IV). Legs: uniformly brown; tibiae with several rows of stout spines; tarsi two-segmented, segment I much shorter than II; pretarsal pulvillus large, reaching near apex of claw.

**SECOND INSTAR** (Fig. 5c). Very similar to first instar in structure and general coloration except larger (length 1.75–1.97), with distinctly longer and broader head (see Appendix 1 for measurements); pronotum slightly more rounded dorsally; abdomen usually more extensively tinged with brown or reddish brown, tergite IX heavily sclerotized; and sclerotized disk surrounding pore of abdominal scent gland larger.

**THIRD INSTAR** (Fig. 5d). Distinguished from earlier instars by larger body size

(length 2.43–2.75), longer and broader head, and much longer rostrum. Male with very small meso- and metathoracic wing pads; female with no wing pad development. Abdominal sternite IX of male with small, sclerotized plate either side of midline, plates broadly separated medially (Fig. 5e); female with pair of medially contiguous plates on ninth sternite (Fig. 5f).

**FOURTH INSTAR.** Male (Fig. 5g). Similar to third instar except larger (length 3.50–3.60), with much longer wing pads and rostrum. Mesothoracic wing pads reaching onto first abdominal sternite; rostrum reaching between mesocoxae or slightly beyond. Sclerotized plates on abdominal sternite IX considerably larger than in third instar, but remaining broadly separated.

Female (Fig. 5h). Similar to male in color and structure, except usually slightly smaller (length 2.80–3.60), with broader vertex and no development of wing pads. Distinguished from third instar female by its larger size, longer and broader head, and much longer rostrum and second antennal segment. Sclerotized plates on ninth abdominal sternite only slightly larger than in third instar.

**FIFTH INSTAR.** Male (Fig. 5i). Similar to fourth instar male except larger (length 4.40–4.80), with longer and broader head, larger eyes, antennal fossa narrowly removed from anterior margin of eye, and much longer rostrum, second antennal segment, and wing pads. Pronotum more trapezoidal with anterior angles very broadly rounded and posterior angles slightly upturned. Mesothoracic wing pads extending to posterior margin of third, or sometimes onto fourth abdominal tergite. Sclerotized plates on ninth abdominal sternite very large and only narrowly separated medially.

Female (Fig. 5j). Similar to male in color and structure except usually slightly smaller (length 4.35–4.55), with longer head, much broader vertex, and no development of wing pads. Distinguished from fourth instar female by larger body size, larger and broader head, and much longer rostrum and second antennal segment. Sclerotized plates on ninth abdominal sternite much larger than those of third and fourth instars.

*Distribution and abundance.* Although *insignis* would be considered a common myrmecomorphic mirid, its distribution is patchy among sites (Fig. 6). Of the 20 sites sampled in the Pike Creek drainage, *insignis* was common or abundant (maximum incidence equal to or greater than 0.50 per plant) at only six, which ranged in elevation from 1,577 m to 2,069 m. No individuals were collected at the lowest four sites, and because *L. caudatus* is limited to drier habitats, few *Coquillettia* individuals were found on the wetter north-facing slopes.

Dispersion within sites among single plants is approximated by a negative binomial model, indicating a clumped distribution (Fig. 8—Lloyd's mean crowding index increasing with mean density—Southwood, 1978). This clumping of individuals among plants may be explained in part by their propensity to select younger, larger, and better than average condition plants—these plant qualities also are dispersed aggregatively (McIver, pers. obs.).

*Coquillettia* was clearly the most abundant and widely distributed species of mirid on *L. caudatus* in the Pike Creek basin, with *Lopidea* nr. *rolfsi* (Orthotylinae: Orthotylini) the only other common mirid. *Coquillettia* represented 16.4% of all herbivorous insects collected on lupine at the CONF and PLAT sites over the 5-week period when it was most abundant (1 June to 5 July) (Table 2). The total numbers of *insignis* and Formicidae collected on 6,824 lupine plants over the entire field

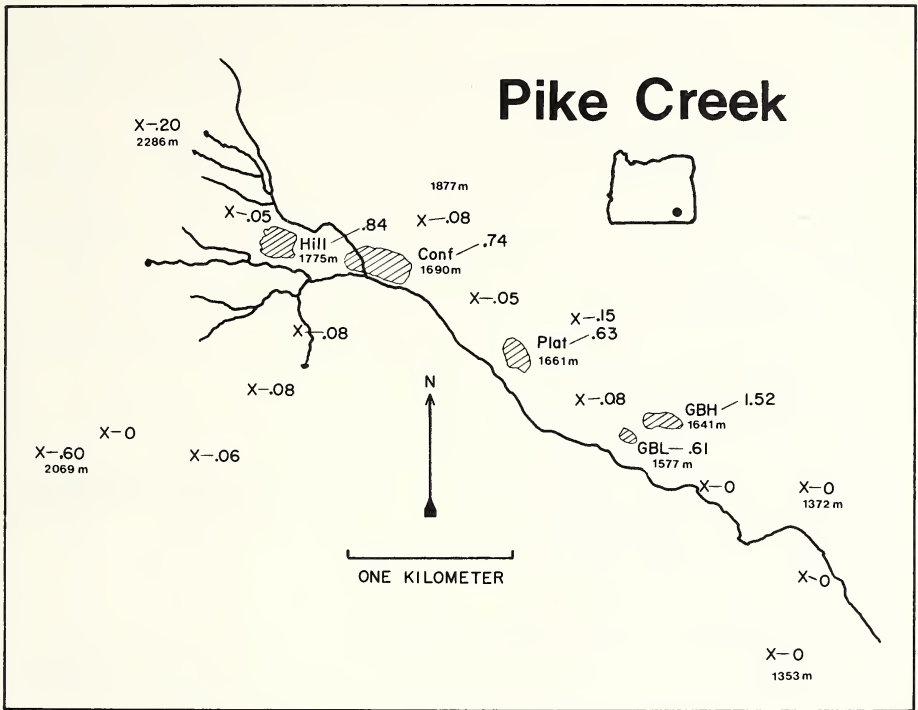


Fig. 6. Pike Creek drainage, southeastern Oregon. Hatched areas denote primary sites; proportions are maximum *C. insignis* numbers per plant from 23 May to 9 August 1985; elevations at selected sites in meters.

season (23 May to 11 July 1985) at all 20 sites were 1,346 and 1,627, respectively, indicating the abundance of this myrmecomorphic mirid relative to ants and other insects.

The pattern of abundance of *insignis* over time was influenced by elevation with abundance peaking earlier at the lower sites (GBL, GBH) than at the higher sites (CONF, HILL) (Fig. 9). Since elevation influences temperature regimes, both the host plant and *Coquillettia* populations will tend to develop later at higher, cooler sites. This observation is also reflected in regressions of deme developments over time for the five primary sites (Fig. 10). The differences in both slope and y-intercept among these regression lines are highly significant (ANAL. COVAR;  $P < 0.01$ ), suggesting that speed of deme development is greater and mean hatching date is later at the higher sites. For example, at the HILL site, the population did not reach an index of 3.0 until 14 June, indicating that most or all of postembryonic development occurred during the warm month of June. After 14 June, the population required only 20 days to reach maturity, which is consistent with the estimate of 20.43 days obtained under optimal conditions of laboratory rearing at the BASE camp. Lower sites, like GBL and GBH, have populations that develop more slowly, probably



Table 2. Relative abundance of arthropod species collected on 3,625 *L. caudatus* plants from 1 June to 3 July 1985 at the CONF and PLAT sites, Pike Creek basin, southeastern Oregon.

Taxa	Abundance on 3,625 plants	Percentage of category
Herbivores		
<i>Coquillettia insignis</i> Uhler	641	16.4
<i>Lopidea</i> nr. <i>rolfsi</i> Knight	328	8.4
Other herbivores	2,930	75.1
Total herbivores	3,899	100.0
Formicidae [correspondence to <i>C. insignis</i> stadium]		
Dolichoderinae		
<i>Tapinoma sessile</i> (Say) [3rd]	28	4.3
Formicinae		
<i>Camponotus essigi</i> Smith [none]		
<i>Camponotus vicinus</i> Mayr [none]		
<i>Formica fusca</i> group [5th, AD]	27	4.1
<i>Formica haemorrhoidalis</i> [5th]		
<i>Formica neogagates</i> group [5th, AD]	332	51.0
<i>Formica obscuripes</i> Forel [AD]	41	6.3
<i>Lasius alienus</i> (Foerster) [3rd, 4th]		
<i>Lasius niger</i> (Linnaeus) [3rd, 4th]		
Myrmicinae		
<i>Aphaenogaster subterranea occidentalis</i> (Emery) [3rd, 4th]		
<i>Crematogaster mormonum</i> Emery [4th, 5th]	147	22.6
<i>Leptothorax nevadensis</i> Wheeler [3rd]	76	11.7
Total Formicidae (caught during sampling study)	652	100.0
Arthropod predators		
Araneae		
<i>Metaphidippus/Eris</i> sp.	2	0.6
<i>Misumena vatia</i> (Clerck)	2	0.6
<i>Misumenops celer</i> (Hentz) & <i>M. asperatus</i> (Hentz)	126	40.0
<i>Oxyopes scalaris</i> Hentz	17	5.4
<i>Phidippus</i> sp.	1	0.3
<i>Philodromus insperatus</i> Schick	2	0.6
<i>Sassacus papenhoei</i> G. & E. Peckham	33	10.8
<i>Synageles</i> sp.	2	0.6
<i>Thanatus</i> sp. imm.	8	2.7
<i>Tibellus chamberlini</i> Gertsch	7	2.4
<i>Xysticus montanensis</i> Keyserling	2	0.6
Hemiptera		
<i>Geocoris</i> sp. imm.	1	0.3
<i>Nabica vanduzeei</i> (Kirkaldy) & <i>Nabis alternatus</i> <i>uniformis</i> Harris	47	14.7
<i>Phytocoris</i> sp. imm.	2	0.6
<i>Sinea diadema</i> (Fabricius)	32	10.1
Undetermined imm. Reduviidae	30	9.8
Total visual predators	312	100.0
Total non-visual predators	47	13.0

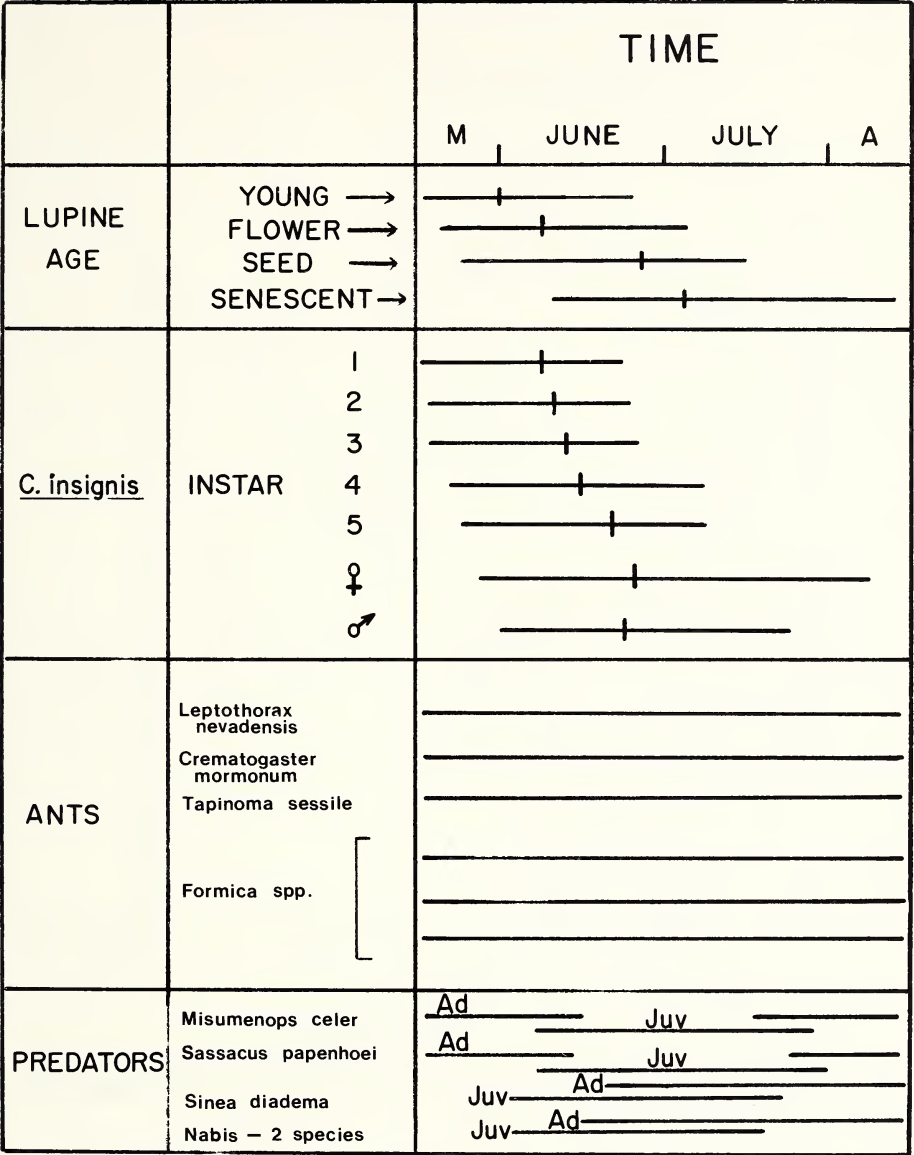


Fig. 7. Phenology of *L. caudatus*, *C. insignis*, and the primary ants and predators collected on lupine, 23 May–10 August 1985.

because much of postembryonic development occurs during the cooler month of May (Fig. 10).

*Behavior.* Thirteen individuals of *insignis* were observed continuously for 585 minutes in May, June and July 1985. Since behavior varied little among stadia,

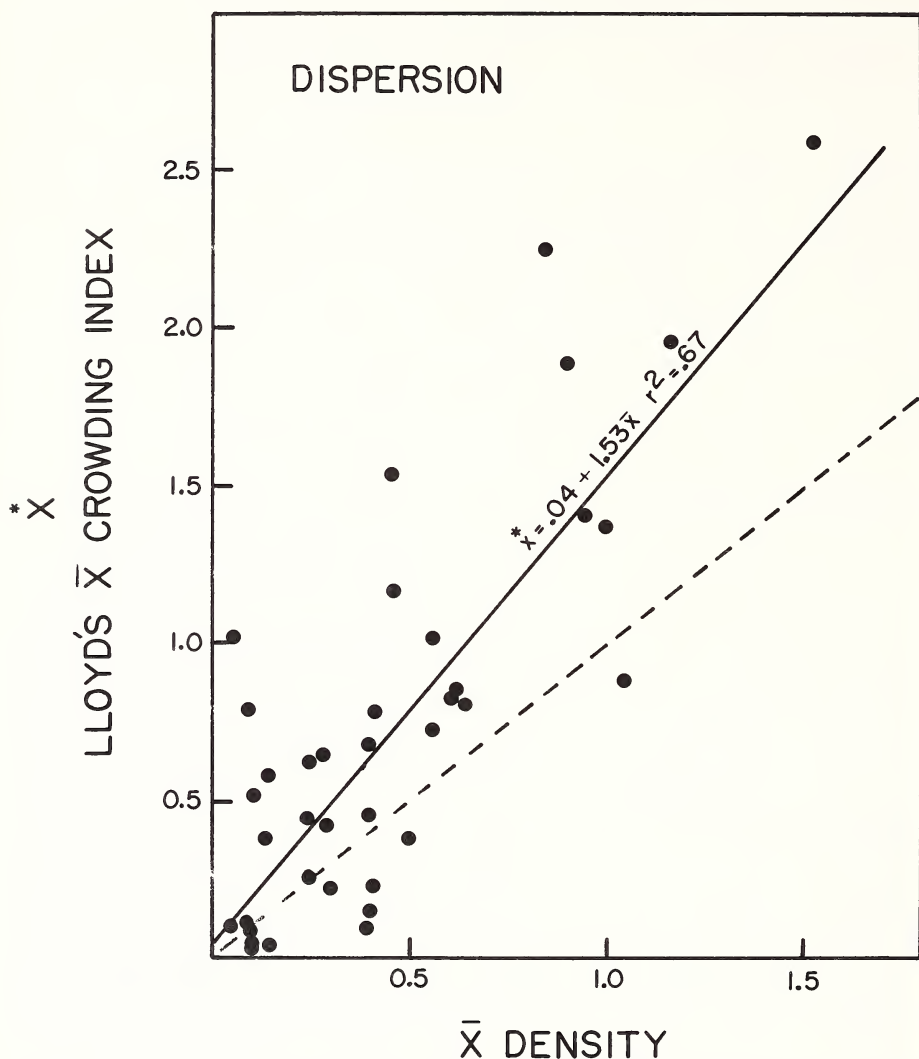


Fig. 8. Dispersion of *C. insignis* individuals among plants. Each point represents a sample characterized by a mean density (x-axis) and a mean crowding index (y-axis); dashed line is line of slope 1.

observational data are pooled in this analysis. Eight different behavioral activities were identified, excluding mating and oviposition (Fig. 11). The majority of active time was spent feeding (on flower primordia, leaflets, and seedpods) and in searching for appropriate food resource. Two types of searching were observed—a 'run-search' with the insect leaving a resource, tucking its proboscis in and hurrying to another resource patch, and 'probe-search,' with the insect proceeding at a much slower pace and using the proboscis to briefly sample potential resource patches. Feeding usually

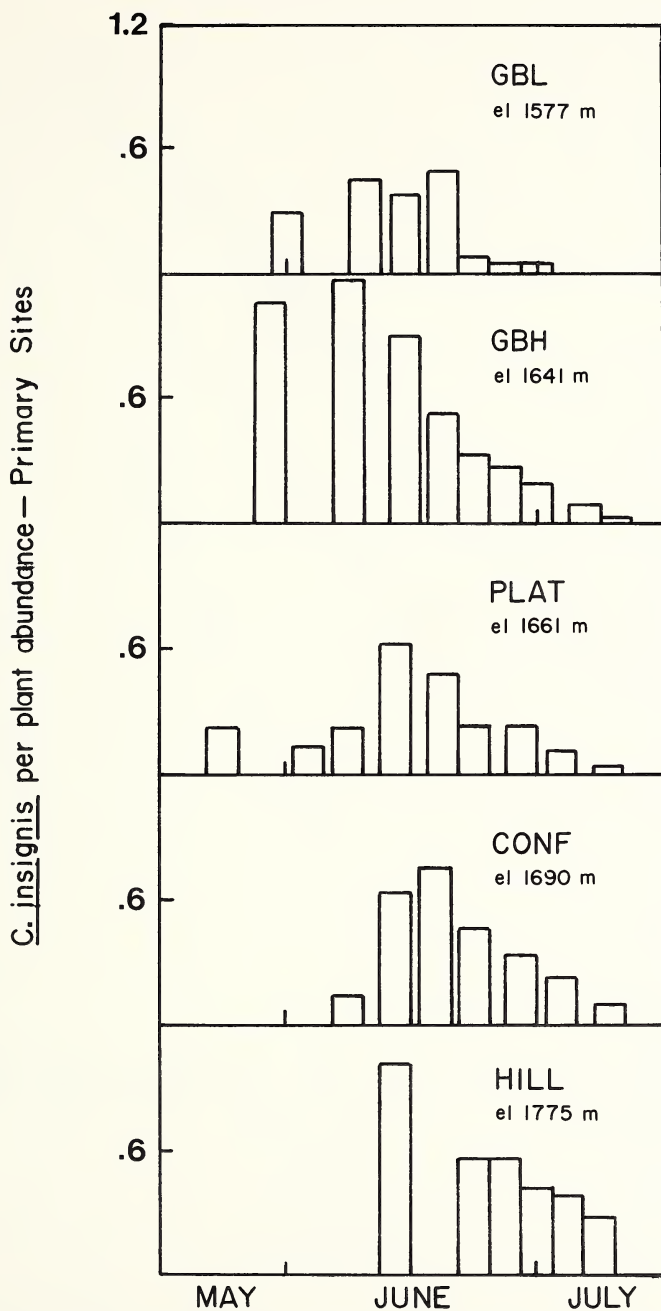


Fig. 9. Number of *C. insignis* individuals per lupine plant from late May to early July 1985, at the five primary sites in the Pike Creek drainage, southeastern Oregon.



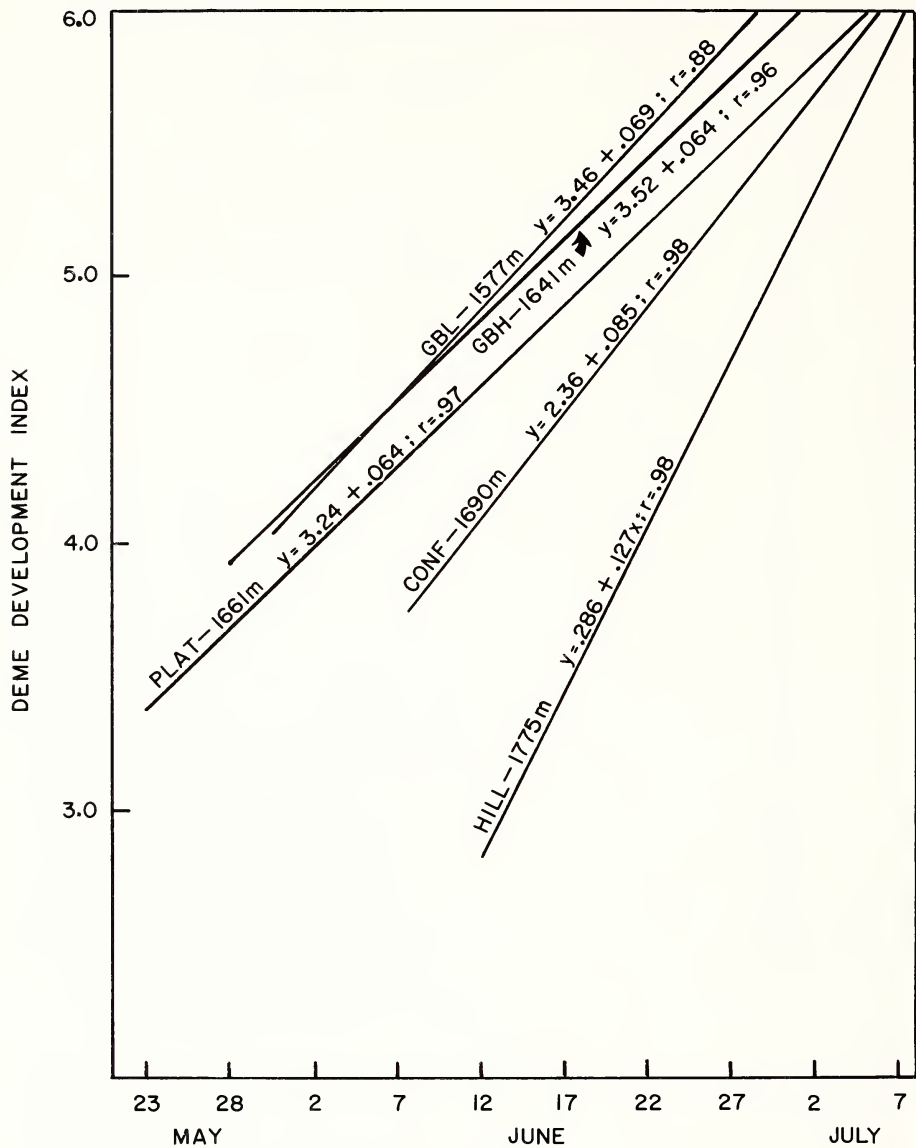


Fig. 10. Regressions of deme development index,

$$\left(\sum_{i=1}^6 n_i \cdot i\right)/N,$$

versus time for the five primary sites in the Pike Creek drainage, southeastern Oregon. All regressions are significantly different in y-intercept and slope (ANAL. of COVAR.,  $P < 0.01$ ).

involved a sequence of inserting the proboscis into plant tissue for a brief period of time ( $\bar{x}$  = 40.4 seconds per probe-feeding bout), probe-searching for a short distance, and then reinserting the proboscis. During this probe-feeding activity, the animal was always alert and responsive to outside stimuli, with both antennae gently swaying alternately. While probe-feeding constituted 29.8% of the total time budget, an animal occasionally (5.9% of total time) fed in a more intense manner, inserting the proboscis into the plant tissue for relatively longer lengths of time ( $\bar{x}$  = 102.7 seconds per feeding bout) and being much less responsive to outside stimuli. Only during this type of feeding behavior could the animal be approached and observed with a hand lens. No predatory behavior was observed, and it can be assumed that *insignis* is a visually oriented, relatively host specific diurnal herbivore.

The remainder of the time budget was consumed by 'resting' (16.9%) and 'grooming' (2.9%) behaviors. During the rest stage, the animal was alert and responsive, but immobile. Two types of rest were identified, an 'active' rest and a more passive rest. During active rest, the antennae would gently sway as in feeding, while during passive rest, all parts of the body were held motionless. Active rest typically occurred just after and just before another behavioral activity, while passive rest typically occurred between periods of active rest. Both types of rest generally took place on the underside of leaflets or stems, or in the stubble near the base of the lupine plant.

Grooming is a behavior undertaken by most insects and spiders and is necessary for keeping important body parts free of fouling material. *Coquillettia* individuals spent 2.9% of their active time in the grooming mode and were observed grooming the face, eyes, antennae, proboscis, and all three pairs of legs. Tarsi of the front pair of legs were used to groom all head-associated parts, while the 2nd and 3rd pairs of legs were usually rubbed against each other.

When this time budget is compared to budgets for two other mirid species (Fig. 11), some interesting patterns emerge. All three species spend a similar proportion of time grooming and feeding, two activities necessary for maintenance and growth. But the three species differ considerably in how they spend the rest of their time. *Lopidea* individuals spend over half of their time resting (58.5%), with very little time devoted to running (6.2%) and probing (0.4%). *Coquillettia* individuals run (29.8%) and probe (11.8%) more, but spend much less time resting (16.9%). The time budgeted to run and rest by *Orectoderus* individuals is intermediate to the values observed for *Lopidea* and *Coquillettia*. The same sequence (Lop-Orecto-Coq) is reflected in the extent to which these three species resemble ants morphologically. The non-myrmecomorphic *Lopidea* has a more typical plant bug shape with a relatively low length : width ratio (length measured from tip of tylus to apex of abdomen, width measured between 2nd and 3rd abdominal segments;  $2.74 \pm 0.41$  = 95% conf. interval;  $N = 9$ ). *Orectoderus*, a close relative of *Coquillettia*, is very ant-like, with a length : width ratio of ( $4.47 \pm 0.33$ ;  $N = 28$ ). *Coquillettia* is even more linear ( $6.55 \pm 0.35$ ;  $N = 38$ ), and its morphological resemblance to ants more convincing than *Orectoderus* (see McIver and Stonedahl, 1987 for comparison). Behaviorally, *Lopidea* is much slower afoot than either *Orectoderus* or *Coquillettia*, with *insignis* clearly the quickest of the three. The speed at which individuals of *insignis* conduct various behavioral activities is reflected in the time budgets, with a greater proportion of time spent run-searching and a lesser amount of time spent resting relative to the other species. Moreover, estimates of behavioral changes per minute and distance

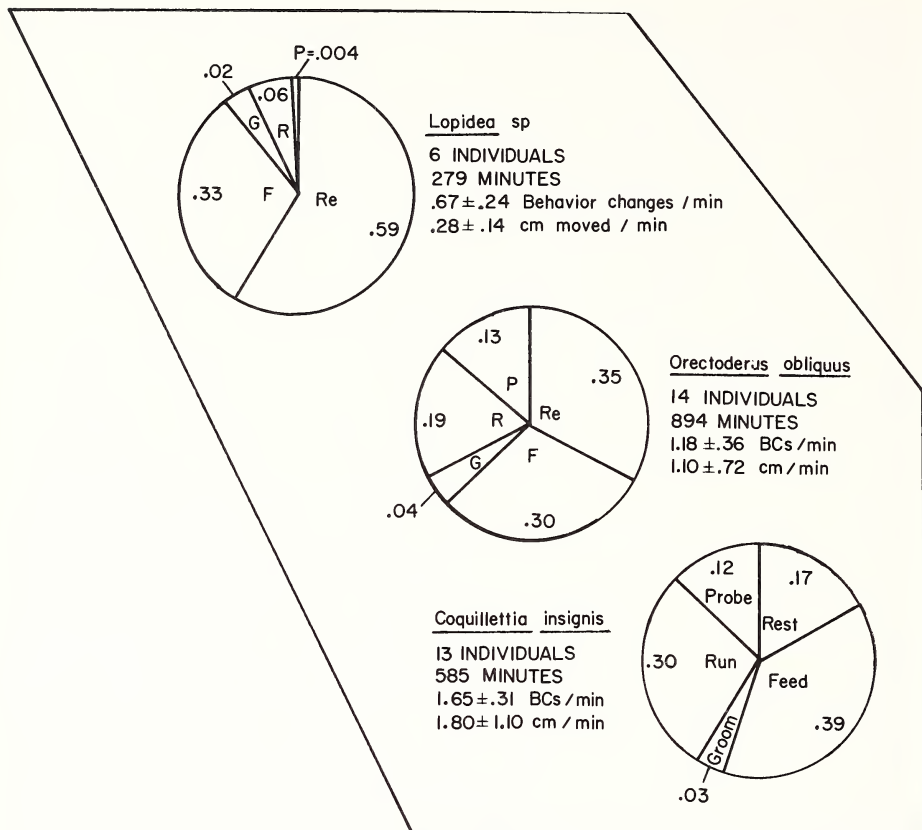


Fig. 11. Relative proportion of time spent in five behavioral categories for *Lopidea* nr. *rolfsi*, *Orectoderus obliquus*, and *Coquillettia insignis*. Observations of *Orectoderus* made July–August 1984, H. J. Andrews Experimental Forest, central Cascades, Oregon; observations on *Lopidea* and *Coquillettia* made May–July 1985, Pike Creek drainage, southeastern Oregon.

moved per minute both indicate that *Coquillettia* is generally more frenetic during its active period (Fig. 11). This frenetic behavior, coupled with its morphology, makes *insignis* a very convincing myrmecomorph, since ants are generally both linear and quick afoot (McIver, 1987).

One instance of territoriality between adult females was observed, with the defended resource being flower primordia. In this incident, two females were engaged in a confrontation for approximately 15 minutes, where the larger of the pair succeeded in preventing the smaller from using a cluster of flower primordia by chasing and making aggressive contact with the front legs. The smaller female was driven off six times within the 15-minute period.

*Possible ant models.* Twelve ant species were collected on or around lupine by sweep-net, beat-sheet, and pitfall trap over the 10-week study period (Table 2). Six species occurred commonly on lupine, with the rank order of abundance *Formica*

*neogagates* group—*Crematogaster mormonum* Emery—*Leptothorax nevadensis* Wheeler—*Formica obscuripes* Forel—*Tapinoma sessile* (Say)—*Formica fusca* group. These ant species differ considerably in size, shape, color, and behavior, and so the correspondence between these species and *Coquillettia* individuals can only be described in general terms: there is no single ant-like morphology or behavior that would serve as a specific model toward which ant-mimics might evolve.

The three common *Formica* species are large, fast, and relatively aggressive, and might serve as general models for the 4th and 5th instar *Coquillettia* nymphs, and the adult female. Although the *Formica* species have much larger heads than similarly-sized *Coquillettia*, the overall body correspondence between models and mimic is remarkably close. Moreover, running behavior is much the same in the *Formica* species and adult female of *Coquillettia* (see McIver, 1987), making field discrimination difficult.

Further, the adult female of *insignis* is polymorphic in general coloration, with a graded series of RED/BLACK to BLACK morphs occurring in most populations. The common morph is black, by a ratio of 3:1 (211:79) over sites where both extremes are abundant. The three common *Formica* species that correspond to adult females in size can be found at the same sites as the myrmecomorph with body colorations closely approximating the two morphs of *Coquillettia*. The red *Coquillettia* morph and *F. obscuripes* are both red on the head, antennae, and thorax, and dark brown on the abdomen, with the only difference being the legs (rusty red for *Coquillettia* and dark brown for *F. obscuripes*). The black *Coquillettia* morph, as well as *Formica fusca* group and *F. neogagates* group, are dark brown to black on the head, thorax, legs, and abdomen, and red on the antennae. We have observed similar patterns of color-polymorphism in other species of *Coquillettia*, as well as in other genera of ant-like Miridae (e.g., *Orectoderus*, *Paradacerla* Carvalho and Usinger). Whether these correspondences represent fine-tuned mimetic adaptations or mere coincidence is unknown.

The two common myrmecines, *Crematogaster mormonum* and *Leptothorax nevadensis*, have very different morphologies and behaviors when compared to the *Formica* species and to *Coquillettia*. Both are relatively slow moving for ants and run in a smooth, nonstopping manner, unlike *insignis*. They are typically docile and usually found near lupine blooms and seed pods, as opposed to other parts of the plant. *Leptothorax* is matched by 3rd instar *insignis* in size, but is much more linear and different in color, with the thorax and abdomen red and brown, respectively, the opposite of *insignis* nymphs. *Crematogaster* is matched by 4th instar nymphs in size, but has a much larger head and wider abdomen than nymphs of similar size. The only body part of *mormonum* showing the same coloration as in *insignis* nymphs is the brown head.

The dolichoderine *Tapinoma sessile* is a small, docile ant that is matched very closely by 3rd instar *insignis* nymphs. The size ranges for 3rd instar nymphs and *T. sessile* individuals are almost identical and the shape of the dorsal profile very similar because of the relatively small head of this ant. Coloration is the same for all body parts except the abdomen (brown for *Tapinoma* and pale with a reddish tint for *Coquillettia* nymphs).

No common ants of appropriate size were found that could potentially serve as models for the 1st or 2nd instar nymphs of *C. insignis*.



*Predators/operators.* Most available data suggest that the resemblance between ants and solitary myrmecomorphic arthropods like *Coquillettia* is Batesian mimicry, where the mimic resembles a distasteful or dangerous model, is confused with it by visual predators, and gains protection by being avoided significantly more often (Rettenmeyer, 1970; Reiskind, 1977; Oliveira and Sazima, 1984; McIver, 1987). The most common predators that occur on lupine are visual insects (reduviids and nabids) and spiders (salticids, thomisids, philodromids, oxyopids). Nonvisual arthropod predators constituted only 13.0% of the total abundance of predators collected on lupine over the 5-week period of peak *Coquillettia* abundance (Table 2). Other possibly important predators observed were three species of lizards (collared, western-fence, side-blotched) and five principal species of birds (green-tailed towhee, lazuli bunting, rock wren, canyon wren, sage sparrow). Any or all of these visual invertebrate or vertebrate predators could potentially maintain a tripartite ant-mimicry system, involving both *Coquillettia* and its various ant models. We have evidence that species in at least two major families of arthropod predators (Reduviidae, Salticidae) classify *Coquillettia* individuals with ants, rather than with nonmimetic Miridae (McIver, 1987). Our data suggest that the role of visual arthropod predators in maintaining ant-mimetic systems has been underestimated and requires further investigation.

#### ACKNOWLEDGMENTS

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# APPENDIX 1

Table of ranges and means of six measurements (in millimeters) for the nymphs and adults of *C. insignis*. Nymphal measurements were taken from alcohol-preserved specimens; adult measurements from dried specimens; N = 4.

Stage	Tot. length <sup>1</sup>	Head		Ant. seg. II	Rostrum	Mesothoracic wing pad
		Length	Width <sup>2</sup>			
1st instar	1.31-1.70	0.40-0.44	0.34-0.37	0.29-0.35	0.61-0.65	0
	1.51	0.42	0.35	0.30	0.63	0
2nd instar	1.75-1.97	0.50-0.56	0.42-0.45	0.42-0.46	0.70-0.78	0
	1.85	0.54	0.43	0.45	0.75	0
3rd instar	2.43-2.75	0.71-0.75	0.58-0.62	0.66-0.72	1.01-1.04	0.06 <sup>3</sup>
	2.56	0.72	0.60	0.69	1.02	0.06
4th instar						
Male	3.50-3.60	0.85-0.91	0.72-0.75	0.93-1.00	1.25-1.29	0.25-0.30
	3.55	0.88	0.74	0.96	1.27	0.28
Female	2.80-3.60	0.88-0.98	0.71-0.78	0.91-1.00	1.19-1.39	0
	3.14	0.93	0.74	0.96	1.31	0
5th instar						
Male	4.40-4.80	1.00-1.10	0.87-0.90	1.46-1.60	1.54-1.60	0.94-1.60
	4.63	1.05	0.89	1.50	1.57	1.02
Female	4.35-4.55	1.17-1.20	0.91	1.40-1.48	1.64-1.70	0
	4.43	1.19	0.91	1.44	1.67	0
Adult male	4.50-5.15	1.05-1.14	0.90-0.97	1.89-2.32	1.70-1.86	—
	4.74	1.09	0.93	2.14	1.79	—
Adult female	4.45-5.30	1.29-1.56	0.96-1.12	1.88-2.15	1.71-2.01	—
	4.88	1.43	1.04	2.03	1.84	—

<sup>1</sup> Measured from tip of tylus to apex of abdomen.

<sup>2</sup> Measured across eyes in dorsal view.

<sup>3</sup> Male only.

**BIOLOGY OF THE MYRMECOMORPHIC PLANT BUG  
*ORECTODERUS OBLIQUUS* UHLER  
(HETEROPTERA: MIRIDAE: PHYLINAE)**

JAMES D. MCIVER AND GARY M. STONEDAHL

Systematic Entomology Laboratory, Oregon State University,  
Corvallis, Oregon 97331, and  
Department of Entomology, American Museum of Natural History,  
Central Park West at 79th Street, New York, New York 10024

**Abstract.**—The basic biology of the myrmecomorph *Orectoderus obliquus* Uhler (Heteroptera: Miridae: Phylinae) is described, including details of its growth, morphology, phenology, distribution and behavior. We document the temporal relation of *O. obliquus* to its host plant, *Penstemon procerus brachycanthus* (Pennell) Cronq., as well as to species of ants and visual predators that may serve as models and operators in a Batesian mimicry system including *O. obliquus*. The morphological and behavioral correspondence between various stages of the myrmecomorph and the six most common species of potential ant models is described.

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*Orectoderus obliquus* Uhler (Miridae: Phylinae) is a myrmecomorphic plant bug traditionally placed in the tribe Hallodapini (Carvalho, 1958; Knight, 1968). New evidence suggests, however, that *Orectoderus* and its New World relatives *Coquillettia* Uhler and *Teleorhinus* Uhler form a monophyletic group distinct from other hallodapines (R. T. Schuh, pers. comm.). The less ant-like Nearctic genus *Pronotocrepis* Knight and the Palearctic genus *Ethelastia* Reuter also seem to belong to this group.

*Orectoderus* is a North American genus comprised of ten species, of which only *O. obliquus* is found east of the Rocky Mountains. The genus was reviewed by Knight (1968), who described six new species and provided a key to adult males. Our determination of *obliquus* for the present study was based on information in Knight's review in conjunction with an examination of type specimens at the National Museum of Natural History, Washington, D.C. *Orectoderus obliquus* is distinguished from other species of the genus by the large size (length: male 6.7–8.2 mm; female 5.3–5.8 mm), shiny luster of the pronotum and hemelytra, weakly convex calli of the male, and by the structure of the male genitalia.

*Orectoderus obliquus* has a transcontinental distribution in southern Canada and northern United States with deep southward penetration into the Rocky Mountains (Fig. 1). This species is typically associated with grasses and herbaceous flowering plants throughout its range (Knight, 1923, 1941; Kelton, 1980, also gives *Rosa acicularis* Lindl. as host). Knight (1941) reported that it "occurs on the ground" and is "associated with ants." In the western Cascades of Oregon, *obliquus* is strictly associated with *Penstemon procerus brachycanthus* (Pennell) Cronq., which we have identified as a breeding host of this species. Although adults are sometimes found on other herbaceous plants of the subalpine meadow community to which *obliquus* belongs, they do not appear to use these plants for oviposition or as an important food resource.

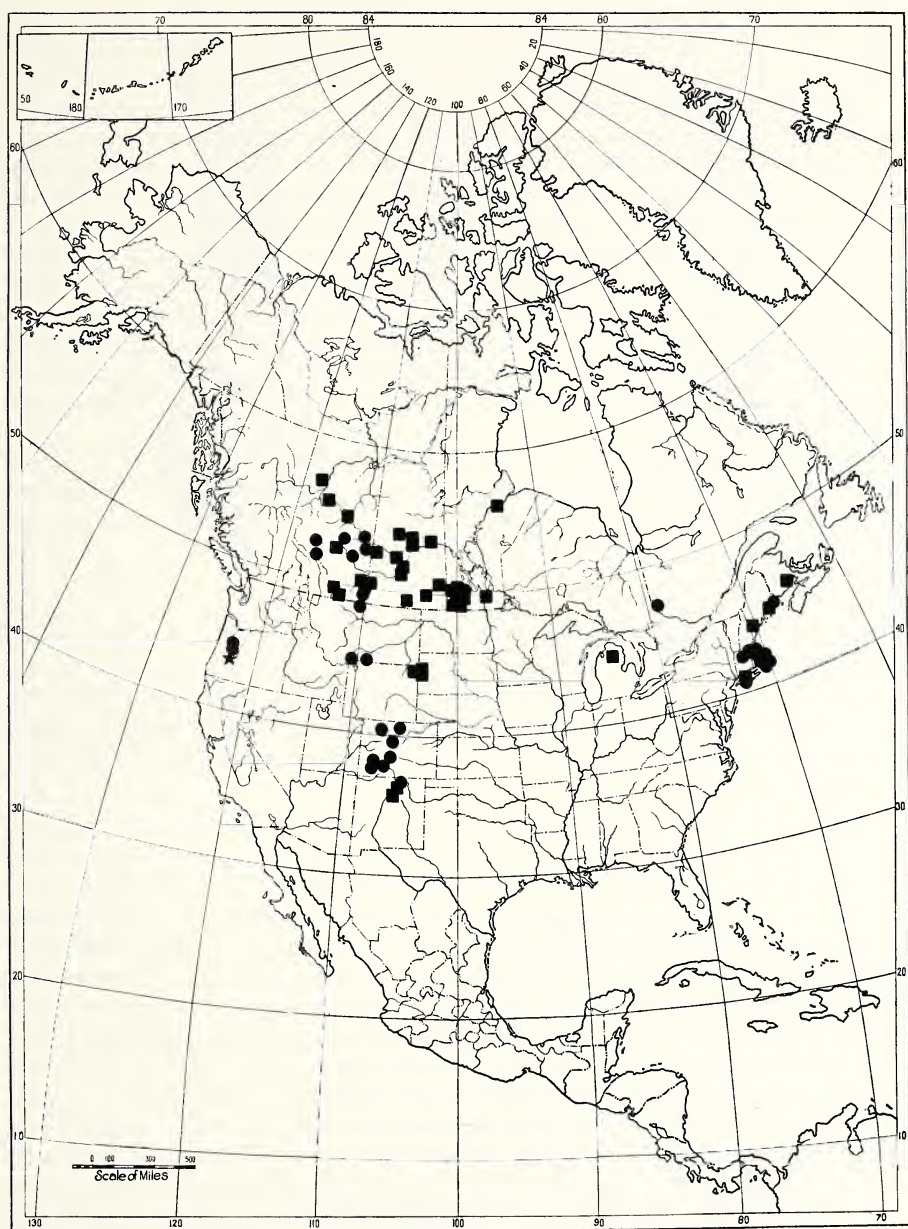


Fig. 1. Distribution of *Orectoderus obliquus* Uhler: ●, records from our examination of museum specimens; ■, other published records (also reported from Connecticut, Illinois, Kansas, Ontario, Pennsylvania, and Washington, without specific locality data); ★, Carpenter Mt. study area in west-central Oregon.



The adults of *obliquus* are sexually dimorphic, with a brachypterous and ant-like female (Fig. 2a). The major myrmecomorphic features of the female are: 1) brachyptery—hemelytra very small, pointed, strongly upturned; 2) elongation and lateral rounding of the thoracic tergites, especially the pronotum; 3) bulbous, petiolate abdomen with the anterior two segments strongly constricted and the lateral margins (connexiva) abruptly upturned; 4) large, elongate head with greatly enlarged gular region; and 5) long, thin legs. The male is macropterous and much less ant-like, lacking most of the thoracic and abdominal modifications of the female (males have weakly constricted anterior abdominal segments). In populations east of and including the Rocky Mountains, the hemelytra of males are sometimes totally black. However, males usually have white markings on the hemelytra, especially in western populations (Fig. 2b). Knight (1923) described the black form as a color variety (*O. obliquus* var. *ferrugineus*), known only from the state of New York. We have examined uniformly black specimens from Colorado, Montana, Massachusetts, New York, and Alberta and Manitoba.

The nymphs of both sexes are fair to good myrmecomorphs, becoming more slender and ant-like with age. Late instar males are less ant-like because of the greatly increased size of the meso- and metathoracic wing pads. Nymphs have extensive pale markings on the first two abdominal segments, that may serve to enhance the petiolate appearance of the abdomen.

*Orectoderus* species all bear a convincing resemblance to ants, and yet there is no published information on their basic biology and ecological relation to ant models and to potential operators. The purpose of this paper is to describe the basic biology of *obliquus* and to identify potential models and operators associated with it. This study, along with a companion paper on *Coquillettia insignis* Uhler (McIver and Stonedahl, 1987) will serve as a base upon which more detailed studies of ant-mimicry will depend.

#### STUDY AREA AND METHODS

*Study area.* The research was conducted from June through August 1983 and 1984 in the H. J. Andrews Experimental Forest, near Blue River, Oregon (122°21'W; 44°10'N). *Orectoderus* populations were studied in four subalpine meadows located on the southern flank of Carpenter Mt., at elevations ranging from 1,370 to 1,465 meters. These steep, well-drained, rocky meadows harbor a rich assemblage of low-growing herbaceous plant species, including the small-flowered penstemon, *Penstemon procerus brachycanthus* (Scrophulariaceae). Individual penstemon plants grow in dense mats and produce tall flowering stalks (15–30 cm) terminating in a dense cluster of small, tubular, blue flowers. Budbreak occurs just after snowmelt (usually early June) and blooming begins in late June to early July. Sampling evidence suggests that *obliquus* occurs primarily on *P. p. brachycanthus*, particularly in the early season. We therefore focused our attention on this plant species to study *Orectoderus* biology, and to examine the relations among *obliquus* individuals, their presumed ant models, and potential operators.

*Methods.* Individuals of *obliquus* ranging from 3rd instar to adult were collected in the four meadows to provide material for description, illustration, and fecundity

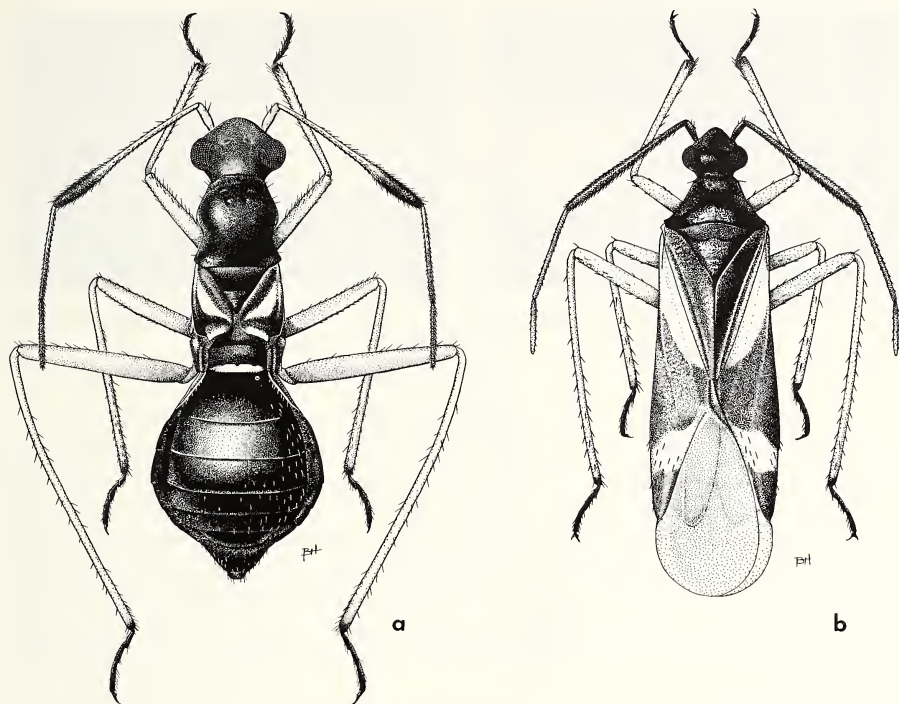


Fig. 2. Adults of *O. obliquus*, dorsal habitus. a. Female. b. Male.

estimates. Forty of these specimens were reared on a penstemon diet at approximately 25°C to obtain information on durations of the 4th and 5th nymphal stadia. Estimates of fecundity (estimated as egg-load) were obtained by dissecting six field-collected and four laboratory-reared females.

A cassette tape recorder was used to record continuous behavioral activity of *O. obliquus* and a time budget was constructed using these observations. A total of 18 hours of observations on 3rd, 4th, and 5th instar nymphs and on adult females were recorded in this manner. These data provide important information on basic habits. Casual observations of behavior (especially predatory and ovipositional behavior) were made throughout each field season to supplement the time budget data.

Penstemon plants in all four meadows were sampled regularly for arthropods from snowmelt in early June to the onset of plant senescence in mid-August 1983 and 1984. Samples were taken with both sweep-net and D-vac device (Echo Power Blower®) and provided information on the phenological relation of *O. obliquus* to its host plant, as well as the temporal correspondence of the myrmecomorph to its potential ant models and arthropod operators. We identified all possible ant models and the common species of potential operators (visual arthropod predators and birds) that occurred on or around the penstemon plants during the active portion of the life cycle of *obliquus*.

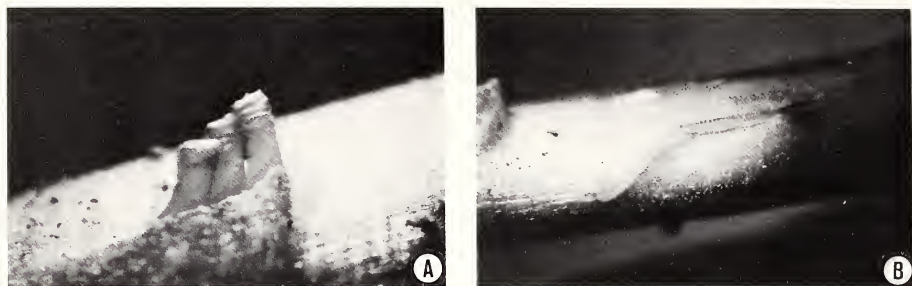


Fig. 3. Eggs of *O. obliquus* in penstemon stem. a. Eggs with neck and operculum exposed. b. Stem with elongate oviposition scar and single well-embedded egg.

#### RESULTS AND DISCUSSION

*The life cycle.* Females of *O. obliquus* deposit their eggs just under the surface of the flowering stems of *P. p. brachycanthus*. The eggs are inserted obliquely to the stem surface, leaving the operculum and chorionic rim collar exposed (Fig. 3). The eggs overwinter in the dried-out, persistent stems and hatching occurs immediately after snowmelt the following spring, usually between late May and late June. Hatching occurs prior to penstemon bloom with early instars remaining in the dense, matted foliage of the plant, making it difficult to collect them by sweep-net or D-vac techniques. We have observed second through fifth instars running on upper parts of the plant.

Nymphs require an average of 5.55 days ( $N = 62$ ,  $SE = 0.22$ , range 2.5–10) to complete a stage, with the fourth and fifth instars requiring 5.57 days ( $N = 21$ ,  $SE = 0.42$ , range 2.5–10) and 6.48 days ( $N = 25$ ,  $SE = 0.21$ , range 3–9), respectively. Thus, total developmental time from eclosion to adult is about four weeks. Hatching date and postembryonic developmental speed thus place *obliquus* on its host plant during peak flowering period, from mid-June to late July. This temporal relation agrees with our observation that *Orectoderus* spends a substantial amount of time feeding on penstemon flowers. The adult is the dominant stage by late July, with mated females ovipositing in flowering stems until about mid-August to complete the life cycle. The ten dissected females (reared and field-collected) had egg loads ranging from 6–30, with an average of 18.2 ( $SE = 2.4$ ).

field-collected) had egg loads ranging from 6–30, with an average of 18.2 ( $SE = 2.4$ ).

*Description of immature stages.* EGG (Fig. 4a). Length 1.50–1.60 mm, greatest width 0.22–0.28 mm; color and structure as described for *Coquillettia insignis* (see McIver and Stonedahl, 1987, fig. 5a), except slightly larger with shorter, broader and apically truncated opercular process and chorionic rim collar.

NYMPHS (Fig. 4b–f). Nymphal descriptions and illustrations are based on alcohol-preserved specimens displaying normal growth and orientation of the various body regions and appendages. Only 3rd–5th instars are treated, as younger stages (1st and 2nd instars) were not encountered in high enough numbers to allow for an adequate sample of specimens. Third through fifth instar nymphs are most easily differentiated by overall length, size of the head capsule, length of the rostrum and second antennal segment, and size of the wing pads. Sex can be determined by the greater development

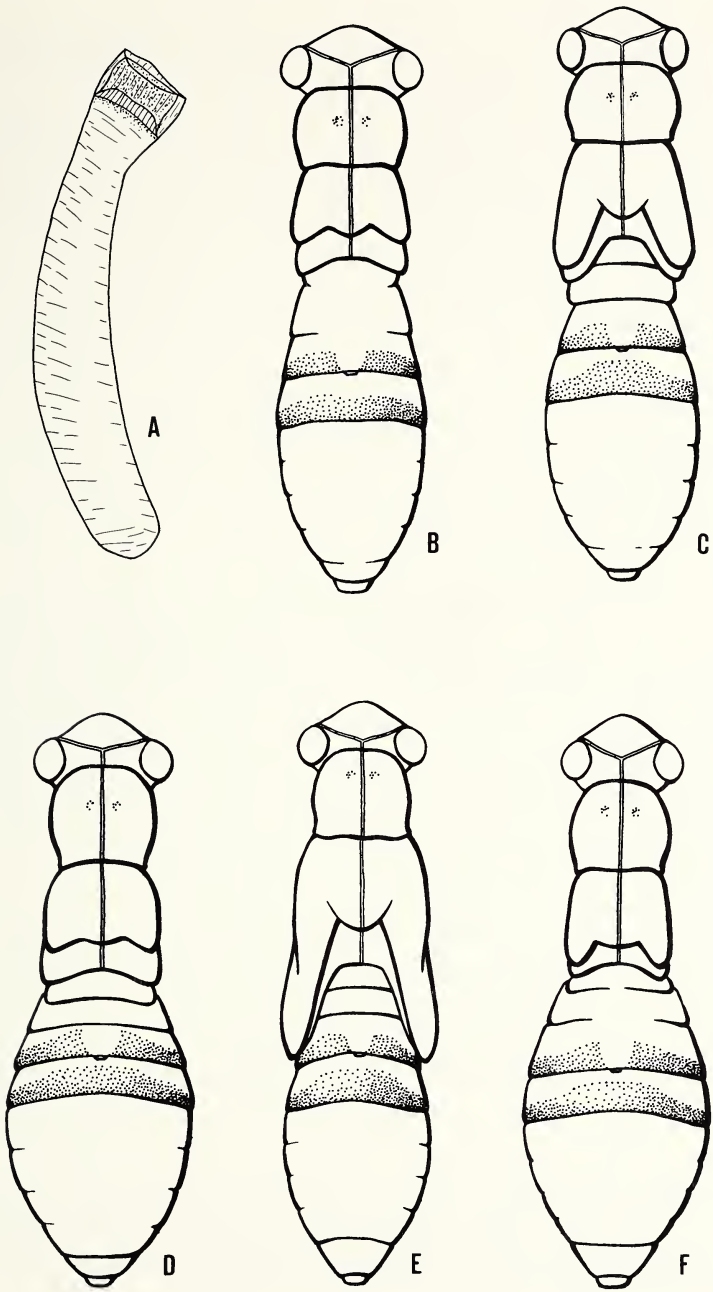


Fig. 4. Immature stages of *O. obliquus*. a. Egg. b. Third instar. c, d. Fourth instar. c. Male. d. Female. e, f. Fifth instar. e. Male. f. Female.



of wing pads in the male and by differences in the position of the sclerotized plates on the ninth abdominal sternite (see following descriptions for detail and fig. 5e, f in McIver and Stonedahl, 1987). All measurements are in millimeters.

**THIRD INSTAR** (Fig. 4b). Length 2.65–2.80; strongly myrmecomorphic; brown or dark brown general coloration; head and thorax, especially pronotal disk, shagreened or finely granulate, moderately shining; dorsum with sparsely distributed, black, bristle-like setae; antennae and legs, especially tibiae, with more densely distributed bristle-like setae. Head: large, subovate, strongly declivous; length 0.77–0.81 (measured from posterodorsal margin to apex of tylus), width across eyes 0.67–0.68, distinctly broader than pronotum, vertex 0.31–0.35; posterior margin rounded; frons broad, weakly convex, junction with tylus indistinct; antennal fossa large, situated well anterior of eye; tylus, jugum, and lorum short; buccula short, narrow; gena and gula well developed, gular region broadly produced. Rostrum: length 1.06–1.11, reaching between metacoxae. Antennae: linear, segment I slightly broader than II–V, narrowed basally; brown or yellowish brown, segment IV sometimes lightly tinged with red; length of antennal segment I 0.18; II, 0.61–0.62; III, 0.48–0.50; IV, 0.46–0.56. Thorax: uniformly brown or dark brown, sternites yellowish brown; pronotal disk broader than long (length 0.38–0.40; median width 0.51–0.59), broadest medially, anterior angles broadly rounded, posterior angles right-angulate, anterior margin slightly concave medially, posterior margin nearly straight, calli indistinct; wing pads short, mesothoracic pair not produced posteriorly in the female, slightly produced in the male, length 0.04 (measured from posterior margin of mesonotum to apex of wing pad). Abdomen: oblong-oval, somewhat bulbous, segments I and II constricted; translucent brownish yellow, except segments I and II opaque creamy white; weakly sclerotized, except tergites III, IV, and IX, and small subspherical lateral plates on tergites V–VIII more heavily sclerotized and dark brown; abdominal sternite IX of female with small sclerotized plate either side of midline, plates narrowly connected medially, male with pair of broadly separated plates on ninth sternite. Legs: uniformly brown, tibiae and tarsi sometimes lighter brown or brownish yellow; pretarsal pulvillus large, reaching beyond apex of claw.

**FOURTH INSTAR MALE** (Fig. 4c). Similar to third instar except larger, rostrum reaching only to apices of mesocoxae or slightly beyond, wing pads longer, and abdomen slightly more sclerotized, with lateral plates on tergites V–VIII and ventral plates on sternite IX slightly larger. Length 3.35–3.80. Head: length 0.88–0.94, width across eyes 0.82–0.85, vertex 0.42–0.45. Rostrum: length 1.41–1.59. Antennae: I, length 0.21–0.23; II, 0.91–0.96, slightly thicker distally; III, 0.64–0.71; IV, 0.60–0.65. Thorax: length of pronotal disk 0.54–0.55, median width 0.65–0.72; length of mesothoracic wing pad 0.32–0.35, reaching to anterior margin of second abdominal tergite.

**FOURTH INSTAR FEMALE** (Fig. 4d). Similar to male, except body usually slightly smaller, and wing pads much shorter. Distinguished from third instar female by larger size, broader head, much longer rostrum and second antennal segment, and mesothoracic wing pads slightly produced posteriorly. Length 3.20–3.25. Head: length 0.92–0.95, width across eyes 0.79–0.84, vertex 0.44. Rostrum: length 1.37–1.51, reaching between metacoxae or nearly so. Antennae: I, length 0.22; II, 0.87–0.88; III, 0.65–0.66; IV, 0.51. Thorax: length of pronotal disk 0.51, median width 0.62–

0.65; length of mesothoracic wing pad 0.06–0.08. Abdomen: eighth sternite with small sclerotized plate on ventroposterior margin.

**FIFTH INSTAR MALE** (Fig. 4e). Similar to fourth instar except body size larger, head broader, and with rostrum, antennal segment II, and wing pads much longer. Length 4.35–4.65. Head: length 1.04–1.11, width across eyes 0.96–1.05, vertex 0.48–0.50. Rostrum: length 2.00–2.15, reaching between mesocoxae or slightly beyond. Antennae: I, length 0.25–0.28; II, 1.26–1.57; III, 0.91–1.06; IV, 0.75–0.88. Thorax: length of pronotal disk 0.65–0.72, median width 0.75–0.90; length of mesothoracic wing pad 0.98–1.25, reaching to posterior margin of third, or sometimes onto fourth abdominal tergite. Abdomen: lateral sclerotized plates on tergites V–VIII and ventral plates on sternite IX much larger than in fourth instar, those on ninth sternite only narrowly separated medially.

**FIFTH INSTAR FEMALE** (Fig. 4f). Similar to male except body usually slightly smaller with much shorter wing pads and second antennal segment more abruptly expanded distally. Distinguished from fourth instar female by larger size, broader head, and longer rostrum, second antennal segment, and wing pads. Length 3.90–4.65. Head: length 1.04–1.19, width across eyes 0.90–1.06, vertex 0.49–0.54. Rostrum: length 1.90–2.17, reaching between metacoxae or slightly beyond. Antennae: I, 0.24–0.31; II, 1.28–1.39, distal third distinctly expanded, more so than in male; III, 0.86–0.94; IV, 0.72–0.76. Thorax: length of pronotal disk 0.62–0.75, median width 0.79–0.90; length of mesothoracic wing pad 0.21–0.25. Abdomen: sternites VIII and IX with large ventral sclerotized plates.

**Behavior.** A total of 14 individuals of *O. obliquus* (2nd instar to adult) were observed continuously on *P. p. brachycanthus* for 894 minutes in July and August 1984. Behavior varied little among life history stages, and so all observations are pooled in this analysis. In general, *O. obliquus* is an active, diurnal plant bug that feeds primarily on the plant juices of *P. p. brachycanthus*. Individuals do not interact with ants or other insects in any way, and until mating, lead completely solitary lives. These visually-oriented herbivores divide their time into five fairly distinct behavioral categories: 'rest,' feed, groom, run, and probe.

The 'rest' phase is defined as complete inactivity and occurred 34.5% of the time. While resting, the insect was responsive to outside visual stimuli, but remained immobile with the proboscis tucked in. Bugs usually rested on the lower portions of the plant, and on the underside of penstemon leaves. Interspersed with periods of rest were extended bouts of feeding, during which the proboscis was inserted into a leaf, stem, or flower and plant juices extracted. Over half of the total amount of feeding time was spent sampling flowers or chlorotic areas of leaf tissue. The average duration of a feeding bout was 164 seconds, during which time the antennae were gently waved and the insect was relatively unresponsive to external visual stimuli. About 30% of the time budget consisted of plant-feeding, suggesting that *O. obliquus* is primarily an herbivore—only two individuals were observed feeding on other insects (both aphids) in the 894 minutes of observation.

Grooming behavior was observed at fairly regular intervals, usually just after feeding. *Orectoderus* individuals spent a total of 3.6% of their time grooming the face, eyes, antennae, proboscis, and all three pairs of legs. Tarsi of the first pair of legs were used to groom all head-associated parts, while the 2nd and 3rd pairs of

legs were rubbed against one another. The amount of time spent grooming is similar to that observed for two other mirid species, the myrmecomorph *Coquillettia insignis* Uhler and the non-mimetic orthotyline *Lopidea rolfsi* Knight (McIver and Stonedahl, 1987), suggesting that this activity is essential to basic body maintenance in plant bugs.

*Orectoderus* is a very active plant bug, spending a significant amount of time (19%) running rapidly from one point to another on its host plant or between host plant patches. During the run mode, the antennae are waved about and the proboscis is tucked in. Very often, an individual will slow down and insert the proboscis into plant tissue for a brief period of time (probing, 12.6%). Presumably, this behavior serves to assess the quality of the resource, since probing periods are very often followed by feeding. Individual bugs tended to remain on a single plant for long periods of time, but were commonly observed running along the ground between host plants. The amount of observed interplant movement suggests that individual bugs can disperse significant distances by running. This observation is supported by the fact that adults of both sexes were collected on a variety of plant species in habitats adjacent to the rocky meadows where *P. p. brachycanthus* grows. Clearly, both macropterous males and brachypterous females move among meadows, at least on a local scale.

*Possible models and operators.* A total of eleven species of ants were collected on and around *P. p. brachycanthus* from June through August 1983 and 1984, of which six were particularly common (Fig. 5). The common species vary considerably in size, shape, color, and behavior, and so the overall correspondence between these species and *O. obliquus* varies accordingly. With respect to morphology and behavior, *O. obliquus* (as well as other hemimetabolous myrmecomorphs) potentially belongs to a 'transformational' mimetic complex (Reiskind, 1972), where at least two genera and six species of ants may serve as models for the various instars.

There are no ant models of appropriate size for the first and second instars of *O. obliquus*. Third instar nymphs correspond in size to the myrmecine *Leptothorax muscorum* (Nylander) and to the dolichoderine *Tapinoma sessile* (Say) (Fig. 5). Because of the lighter color, strongly constricted body, and relatively slow, non-stopping running behavior, *L. muscorum* is unlikely to be an effective model for third instar nymphs which are darker, less constricted, and quicker afoot. A much closer correspondence in morphology and behavior is observed between *T. sessile* and third instar *O. obliquus*, because this ant species is dark brown, has a less constricted body and is very active. Fourth instar nymphs correspond in size to only one common ant species, *Formica lasioides* Emery. The dark color and close match in size and shape make 4th instar *O. obliquus* convincing mimics of *F. lasioides*. Three other *Formica* species may serve as models for fifth instar nymphs: *F. altipetens* Wheeler, *F. fusca* Linnaeus, and *F. neorufibarbis* Emery. Because of caste and morph variability, individuals of these three species also are similar in size to adult females of *O. obliquus*. Since *Formica* species are similar in shape to *O. obliquus* and are also very active, these correspondences in size, shape and behavior between mimics and presumed models are convincing. However, both *F. altipetens* and *F. neorufibarbis* are 'red' ants and hence, are easily distinguished from darker *O. obliquus*. It is interesting that color variation in the adults of *Orectoderus* species and within species



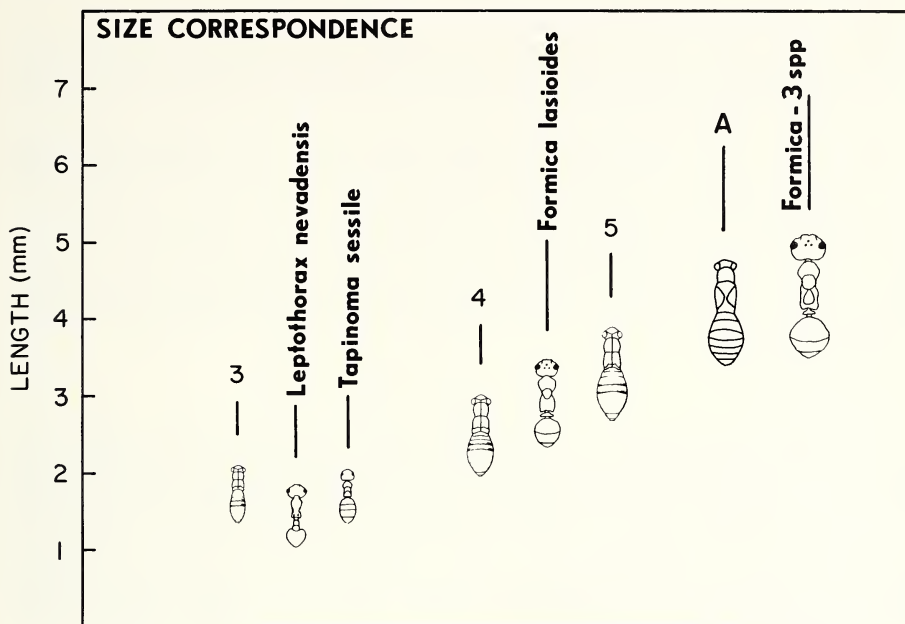


Fig. 5. Correspondence in size and shape between female *Orectoderus obliquus* (3rd instar to adult) and the six most common co-occurring ant species; Carpenter Mt., H. J. Andrews Exp. Forest, Oregon.

of other ant-like mirids (e.g., *Paradacerta* Carvalho and Usinger, *Coquillettia*) tend to be expressed as a dimorphism of red versus brown phenotypes, with the distribution of color among body parts closely paralleling color distribution in various *Formica* species. It is not known if these color patterns are relevant to the mimicry systems within which these species presumably interact.

Although there is evidence that some myrmecomorphic insects derive benefit from their appearance by gaining access to or preying on ants (Oliveira and Sazima, 1984), most myrmecomorphs are probably Batesian mimics (Reiskind, 1977; McIver, 1987). Most ants defend themselves with some combination of mandibles, stings or noxious chemicals (Wilson, 1971), and it is likely that many visual predators learn to associate these characters with ant morphology and/or behavior, subsequently avoiding not only ants, but other arthropods that resemble them (Wickler, 1968). Although it is difficult to identify the operators that may actually maintain a mimetic system in *O. obliquus*, it is likely that predators such as small birds and visual arthropods are involved. We identified several species of ground-foraging birds on our study sites, including dark-eyed juncos, varied thrushes, American robins, and cedar waxwings. The arthropod predator fauna is potentially more diverse. We collected seven very common species of visual predators on *P. p. brachycanthus*, including five species of salticid spiders (*Eris margineta* (Walck.), *Phidippus johnsoni* G. & E. Peckham, *Habronattus viridipes* (Hentz), *Sassacus* sp., and *Metaphidippus* sp.), an oxyopid



spider (*Oxyopes scalaris* Hentz), and a very common damsel bug (*Nabis alternatus uniformis* Harris). Traditionally, arthropods have been excluded from the list of important operators in Batesian mimicry systems, because of their small size, and limited perceptive and learning skills. But there is evidence that at least some arthropods are capable of discrimination among prey types and can learn from their experiences (Gelperin, 1968; McIver, 1987). Since ants are well within the acceptable size range preferred by many arthropod predators, it is worthwhile to investigate the possibility that visual arthropods may be important operator species. Both *Orectoderus* and the related genus *Coquillettia* offer excellent opportunities for the study of perception and learning in arthropod predators. Understanding how these predators perceive and learn is critical to identifying their role in the regulation of Batesian mimicry systems.

#### ACKNOWLEDGMENTS

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**A PECULIAR CASE HISTORY:  
*HEMISPHAERODELLA MIRABILIS* REUTER IS THE NYMPHAL  
STAGE OF *CYRTOCAPSUS CALIGINEUS* (STÅL)  
(HETEROPTERA: MIRIDAE: BRYOCORINAE)**

THOMAS J. HENRY AND J. C. M. CARVALHO

Systematic Entomology Laboratory, Agricultural Research Service, USDA, NH-168,  
% U.S. National Museum of Natural History, Washington, D.C. 20560, and  
Museu Nacional, Quinta Boa Vista, Rio de Janeiro, GB, Brazil

*Abstract.*—Based on fieldwork and study of collections, *Hemisphaerodella mirabilis* Reuter is shown to be the immature stage of *Cyrtocapsus caligineus* (Stål). The monotypic genus *Hemisphaerodella* Reuter, therefore, is considered a junior synonym of *Cyrtocapsus* Reuter, and *H. mirabilis*, a junior synonym of *C. caligineus*. A key to the species of *Cyrtocapsus* is provided to help workers recognize and associate adults with the respective nymphs.

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The history of the monotypic genus *Hemisphaerodella* Reuter leading to the present paper represents one of the more peculiar stories in heteropterology. The species *Hemisphaerodella mirabilis* Reuter, 1908, originally described from Cuba and the Dominican Republic [as Santo Domingo], has since been recorded from Brazil, Puerto Rico, and Florida (USA). We have collected other examples in Mexico and additional states of Brazil. In this paper we show that *Hemisphaerodella mirabilis* and its junior synonym *Lopesiella mirabilis* Wygodzinsky, described from Brazil, are the immature stages of *Cyrtocapsus caligineus* (Stål) and, possibly, other species of *Cyrtocapsus*.

That *H. mirabilis* has puzzled previous workers is illustrated by the following accounts from the literature. Wygodzinsky (1946) said of *Lopesiella mirabilis* [the species epithet is a coincidence]: "Owing to the rather chaotic status of the classification of the groups in Cimicoidea, the systematic position of *Lopesiella* is difficult to fix. Considering the four-jointed rostrum, the absence of ostioles on the metapleura, the very short first joint of the two-jointed tarsi, the almost circular abdomen and the symmetrical genitalia of the male, it is thought best to refer *Lopesiella* to the Microphysidae." Blatchley (1928) noted that Knight (in litt.) had identified several examples for him as "nymphs of *Halticus*" and later Van Duzee (in litt.) referred them to *H. mirabilis*. Although Reuter (1908) correctly placed *H. mirabilis* in the subfamily Bryocorinae, the strange appearance of this mirid caused Blatchley to comment that "In its form of body, peculiar elytra and presence of the so-called "metadorsum" it differs widely from any of our eastern [U.S.] Miridae, and the genus should probably be given subfamily rank." Maldonado (1969), in redescribing *H. mirabilis* from Puerto Rico, explained that this small, black, beetle-like mirid is "pedogenic, so, in the description that follows the sex is not mentioned."

Wygodzinsky (1946) provided detailed illustrations of *H. mirabilis* [as *L. mirabilis*]. Maldonado (1969) gave dorsal and lateral figures, listed sweet potato, *Ipomea batatas*

(L.) Lam. (Convolvulaceae), as the host, and included the genus in his key to the genera of Puerto Rico. Blatchley (1928) noted that "all stages" were taken on the foliage of moonvine, *Ipomea bonanox* L. and sweet potato.

Through personal collecting of *Cyrtocapsus* spp. in Brazil, study of nymphs and adults of *Cyrtocapsus caliginus* from the same host and locality in Texas [a new distribution record] in the USNM collection, and evaluation of the lectotype (USNM) and Wygodzinsky's (1946) and Maldonado's (1969) figures of *H. mirabilis* [both figures of the fifth instar], we can now say that the original description of *H. mirabilis* actually was based on the last nymphal stage [having large, beetlelike wing pads] of a species of *Cyrtocapsus*. Further evidence is interpreted from Maldonado (1969) who listed *I. batatas* as the host for both *C. caliginus* and *H. mirabilis*. Knight, as conveyed by Blatchley (1928), is the only worker to conclude that specimens of "*H. mirabilis*" were nymphs of some mirid species. Certainly the peculiar round body form and the beetlelike wing pads, that form a shell-like cover over the abdomen, are different enough from other more typical mirid nymphs to mislead workers.

The difficulty is associating all records of *H. mirabilis* with a specific *Cyrtocapsus* species is that at least five of the thirteen known species of *Cyrtocapsus* occur over the same range (Carvalho, 1954, 1985). In the United States and Puerto Rico, where the mirid fauna is reasonably well documented, only *Cyrtocapsus caliginus* is known, making all records of *H. mirabilis* from those localities simple to transfer. In Brazil there are at least three species of *Cyrtocapsus* known, including *C. caliginus*, which is also known from Cuba.

A major problem prior to this study was that only *C. haitianus* Carvalho, 1954, was recorded from the island of Hispaniola in Haiti, the approximate type [lectotype] locality of *H. mirabilis*. We now have examined material of *C. caliginus* [2♂♂, 1♀, 3 miles west of Haina, San Cristobal Prov., 18–19 Aug. 1967, J. C. Schaffner coll.; 6 miles north San Victor, Espaillat Prov., 22 Aug. 1967, J.C.S.] and *C. haitiensis* [4♂♂, 4♀♀, 3 miles west of Haina, San Cristobal Prov., 9–22 Aug. 1967, J.C.S.; San Cristobal, San Cristobal Prov., 19 Aug. 1967, J.C.S.; Jarabacoa, La Vega Prov., 9 Aug. 1967, J.C.S.] from the Dominican Republic.

Because the lectotype of *H. mirabilis* is from the Dominican Republic and only two species of *Cyrtocapsus* are known to occur in that country, we are convinced that *H. mirabilis* is a synonym of one of them. Although nymphs of *Cyrtocapsus* are impossible to identify at this time, we note that adults of *C. caliginus* have uniformly pale antennae, whereas those of *C. haitiensis* are black or dark reddish brown. Because the lectotype of *H. mirabilis* has pale antennae, we are reasonably certain this specimen belongs to *C. caliginus*. With this evidence and to maintain as much nomenclatural stability as possible, we are placing *H. mirabilis* as a junior synonym of *C. caliginus*. With this end, we realize that once nymphs are identifiable, specimens on which the description of *Lopesiella mirabilis* are based may eventually prove to represent a different species and certain published records for *H. mirabilis* will require referral to other *Cyrtocapsus* species.

#### Synonymy of the Genus *Cyrtocapsus* Reuter

*Cyrtocapsus* Reuter, 1876:70. Type-species: *Capsus caliginus* Stål, 1859.

*Hemisphaerodella* Reuter, 1908:297. Type-species: *Hemisphaerodella mirabilis* Reuter, 1908. **NEW SYNONYMY.**



*Lopesiella* Wygodzinsky, 1946:334. Type-species: *Lopesiella mirabilis* Wygodzinsky, 1946. Synonymized with *Hemisphaerodella* by Carvalho, 1955:223.

### Synonymy of *Cyrtocapsus caligineus* (Stål)

*Capsus caligineus* Stål, 1859:158.

*Cyrtocapsus caligineus*: Reuter, 1876:78.

*Perithous pallipes* Distant, 1884:302. Synonymized by Reuter, 1892:392.

*Hemisphaerodella mirabilis* Reuter, 1908:297. Lectotype from the Dominican Republic designated by Carvalho, 1955:223. **NEW SYNONYMY.**

*Lopesiella mirabilis* Wygodzinsky, 1946:335. Synonymized with *H. mirabilis* by Carvalho, 1955:223.

Now with some of the past confusion solved, we urge workers to begin investigating the various species of *Cyrtocapsus*, with the eventual intention of publishing their findings accompanied by illustrations of the life stages, study of biology, and documentation of host plants. The feeding preference of *C. caligineus* for *Ipomea* spp. makes it and, possibly, other members of this genus potentially important in agricultural and ornamental situations.

To help in making proper nymphal associations, we offer the following key to adults of *Cyrtocapsus*, revised and updated from Carvalho (1954).

### KEY TO THE SPECIES OF *CYRTOCAPSUS* REUTER

1. Femora, except base, and base of tibiae black; Mexico ..... *marginatus* (Distant)
- Femora and tibiae whitish or pale yellow, at most infuscated apically ..... 2
2. Pronotum predominately black ..... 3
- Pronotum predominately lemon yellow, yellowish brown, or reddish brown ..... 10
3. All coxae whitish ..... 4
- Only anterior pair of coxae at least partially whitish, posterior two pair reddish brown ..... 8
4. First antennal segment black or reddish brown; femora infusate at apex; Haiti ..... *haitiensis* Carvalho
- First antennal segment whitish; femora not infusate near apex ..... 5
5. Head strongly produced below eyes, as seen from frontal view the anteocular part two-thirds longer than the ocular part; Chile ..... *rostratus* Reuter
- Anteocular part of head, as seen from the frontal view, about as long as or shorter than ocular part ..... 6
6. Embolium and outer margin of cuneus dark reddish brown to rosy or rusty reddish brown; second antennal segment reddish at apex; Trinidad ..... *intermedius* Reuter
- Embolium black; second antennal segment whitish ..... 7
7. Second antennal segment longer than first; South America ..... *femoralis* Reuter
- Second antennal segment as long as first segment; Panama, Trinidad ... *nanus* Carvalho
8. Anterior coxae entirely pale or whitish; North, Central, South America, and West Indies ..... *caligineus* (Stål)
- Anterior coxae infusate or black at base ..... 9
9. Second antennal segment 2.2 mm long; anterior coxae white only at apex; South America ..... *andinus* Carvalho
- Second antennal segment less than 2.0 mm long; anterior coxae white on apical half; Dominica, Grenada ..... *grenadensis* Carvalho

10. Pronotum lemon yellow to yellowish brown, at most narrowly fuscous between calli ..... 11
  - Pronotum reddish brown with a wide fuscous area across calli ..... 12
11. Antennae pale; scutellum, clavus, and embolium dark fuscous; Guyana ..... *guianus* Carvalho
  - Antennae, except segment I, black; scutellum and hemelytra uniformly yellowish brown; Brazil ..... *nordestinus* Carvalho
12. Antennal segment I and segment II, except apex, pale; cuneus dark brown or black; Brazil ..... *xinguanus* Carvalho
  - Antennae uniformly pale; cuneus pale along outer margin; Paraguay ..... *paraguaiensis* Carvalho

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**THE TAXONOMIC STATUS OF *ISCHNODEMUS OBLONGUS*  
(FABRICIUS) AND *ISCHNODEMUS VARIEGATUS* (SIGNORET)  
(HEMIPTERA: LYGAEIDAE: BLISSINAE)**

JAMES A. SLATER

Ecology and Evolutionary Biology, The University of Connecticut,  
Storrs, Connecticut 06250

*Abstract.*—*Ischnodemus variegatus* (Signoret) is resurrected from synonymy with *Ischnodemus oblongus* (Fabricius). Important differences between the nymphs of the two species and differences in genitalia and meristic characters of the adults are discussed. *Ischnodemus oblongus* appears to be chiefly Central American in distribution and *I. variegatus* South American. Trinidad records of *I. oblongus* are referred to *variegatus*. Host plants are mentioned. Figures include the fifth instar nymphs, parameres, sperm reservoirs and male genital capsules of both species.

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The following discussion illustrates clearly the importance of associating immature stages with adults when making taxonomic decisions concerning insects with incomplete metamorphosis. In the particular case under consideration the adults of two apparently quite distinct species of *Ischnodemus* are so similar that they were synonymized in the most recent revision of the genus for the Neotropical Region (Slater and Wilcox, 1969).

Subsequently, fieldwork in Panama and Trinidad, where careful attention was paid to associating nymphs with adults, has revealed that nymphs of what had been considered to be *Ischnodemus oblongus* (Fabricius) were so extremely different as to make it improbable that a single species was involved. I recently have been able to find reliable adult differences that seem to confirm that two distinct species are represented as is indicated by the nymphal differences.

Fortunately names exist in the literature for these species. *Ischnodemus oblongus* (material from Panama) was described by Fabricius from "America merid" and *Ischnodemus variegatus* (Signoret) (material from Trinidad) from Colombia.

Baranowski (1979) discussed the biology of two species of *Ischnodemus* from Trinidad. His discussion of *I. oblongus* actually is of *variegatus* which he found to breed on the grass *Hymenachne amplexicaulis* (Rudge) Nees growing in or near shallow ponds and streams. In the same paper Baranowski described the egg and all 5 nymphal instars and illustrated the fifth instar nymph.

Slater and Harrington took a series of adults and nymphs of true *oblongus* at Coco Solo (CZ) Panama in 1974 breeding on *Pennisetum purpureum* Schumacher.

Believing only a single species was involved, Slater and Wilcox (1969) stated that *Ischnodemus oblongus* (Fabricius) had one of the most extensive ranges of any Neotropical species of *Ischnodemus*. This statement is probably incorrect now that populations from Panama and Trinidad have proven to represent different species.

Other than the nymphal material from Panama and Trinidad I have seen only a series of dried nymphs from Guyana. These nymphs were apparently taken with

adults of typical *variegatus*, and their features agree with those described below for nymphs of *variegatus* from Trinidad.

DIFFERENCES IN THE FIFTH INSTAR NYMPHS

*Ischnodemus oblongus* (Fig. 3) (material from Panama): 1. Pronotum bicolored, anterior  $\frac{2}{3}$  black, posterior  $\frac{1}{3}$  bright yellow. 2. Abdominal terga I and II between mesothoracic wing pads white or very light yellowish. 3. Abdominal terga 3–5 red mesally and as a stripe along posterior margin that reaches lateral edge of abdomen, thus producing large yellow maculae antero-laterally on each segment (confluent anteriorly on tergum 5). 4. Antennal segments I and II dull yellow somewhat suffused with brown and strongly contrasting with dark coloration of segments III and IV. 5. Labium almost reaching mesocoxae. 6. SM6 sclerite rounded anteriorly. 7. Mesonotum with pale anterior margin.

*Ischnodemus variegatus* (Fig. 4) (material from Trinidad): 1. Pronotum uniformly black. 2. Abdominal terga I between wing pads gray with narrow median yellow stripe on anterior half. Abdominal tergum II dull red. 3. Abdomen chiefly dull red becoming dull grayish laterally, terga 3–4 mesally with a large red  $\frac{1}{2}$  ellipse tapered posteriorly. 4. All antennal segments uniformly black. 5. Labium at most barely attaining anterior portion of mesosternum. 6. SM6 sclerite truncate anteriorly. 7. Mesonotum uniformly black.

Adults of the two species are very similar in size and color but may be distinguished as follows: *Ischnodemus oblongus* has an appreciably longer labium than does *variegatus*. In *oblongus* the labium reaches well onto the mesosternum whereas in *variegatus* it at most attains the anterior part. Since tilting of the head can make this distinction confusing, measurement of the total labial length is more reliable. In the admittedly small series measured there is no overlap in labial length in either sex.

Labial lengths (in millimeters)

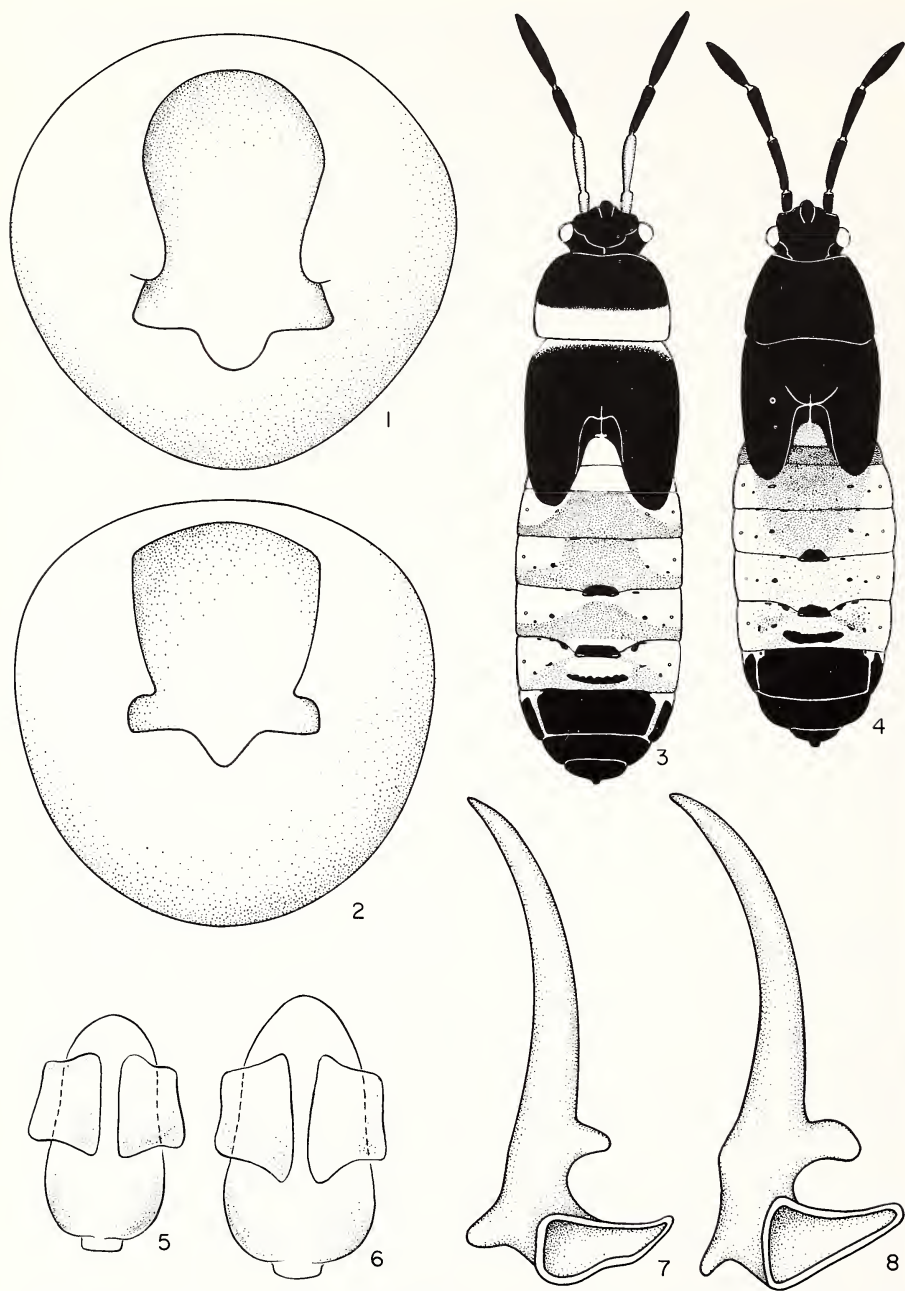
	N	Males		Females	
		Mean	Range	Mean	Range
<i>I. oblongus</i>	8	1.84	1.64–2.08	2.10	2.04–2.18
<i>I. variegatus</i>	12	1.29	1.16–1.40	1.55	1.44–1.60

There are also differences in the color patterns of the adults of the two species. Specimens of *oblongus* have relatively narrow, sometimes obsolete, dark bands near the middle of the hind femora and lack a dark stripe along each side of the claval commissure. Specimens of *variegatus* from northern South America and Brazil have a dark stripe along either side of the claval commissure, and usually the femoral black area is appreciably more extensive. However, Slater and Wilcox (1969) noted color differences in material from southern South America (Uruguay, northern Argentina, and the Paraguayan Chaco). These southern specimens resemble *oblongus* in the femoral coloration and in lacking the claval commissure striping.

It would be especially valuable to examine nymphs from Argentina and Uruguay because the three males and two females examined, besides lacking the claval commissure striping, have a labial length somewhat intermediate between that of *oblongus* and *variegatus* (males—mean 1.45 (1.34–1.56); females—mean 1.78 (1.68–1.88)).

Subtle characteristics of the male genitalia also serve to separate *variegatus* from





Figs. 1, 4, 6, 8. *Ischnodemus variegatus*. 1. Genital capsule dorsal view. 4. Fifth instar nymph dorsal view. 6. Sperm reservoir dorsal view. 8. Paramere.

Figs. 2, 3, 5, 7. *Ischnodemus oblongus*. 2. Genital capsule dorsal view. 3. Fifth instar nymph dorsal view. 5. Sperm reservoir dorsal view. 7. Paramere.

*oblongus*. The most readily distinguishable feature of the male genitalia is the shape of the dorsal opening of the genital capsule. In *oblongus* (Fig. 2) the anterior portion of the margin is abruptly angulate and the angle adjacent to the area in which the parameres lie is slightly produced and subacute. In *variegatus* (Fig. 1) the anterior portion of the inner margin sweeps posteriorly in an almost even arc and the angle adjacent to the area in which the parameres lie is broadly and bluntly rounded.

The parameres are also diagnostic although very similar. In *variegatus* (Fig. 8) the inner projection is more acute and more strongly angled basad than that of *oblongus* (Fig. 7) while the outer projection is relatively larger and more strongly rounded. *Ischnodemus variegatus* also has a more elongate sperm reservoir (Fig. 6) than does *oblongus* (Fig. 5). However, both paramere and reservoir shape are so similar in the two species and orientation so critical that comparative material is almost essential to be able to use these characters successfully.

Slater and Wilcox (1969) reported *oblongus* from Argentina, Bolivia, Brazil, Guyana, Belize, Colombia, French Guiana, Paraguay, Surinam, Peru, Uruguay, Venezuela, and Trinidad. I have reexamined material from most of the above countries. Based on adult features it pertains to *variegatus*. The record of *oblongus* from Trinidad is in error. It is based upon a misreading of Panamanian specimens labeled "Trinidad Rio Pan., 8.VI.72, A. Busck coll."

From the material currently available I conclude that *Ischnodemus oblongus* (Fabricius) is restricted to Central America (specimens examined only from Panama and Costa Rica). All specimens thus far known from South America are now referred to *Ischnodemus variegatus* (Signoret) which is here raised from junior synonymy with *oblongus* with which it was synonymized by Slater and Wilcox (1969). However, these species are not completely allopatric since typical specimens of *variegatus* occur in Central America. I have examined two males from the Chiriqui Mts. of Panama (26 mi NW Guabala Jcn., 25.VI.1974, C. W. & L. O'Brien & Marshall) and one male from Belize (San Antonio, VI.1931, J. J. White). Thus *variegatus* probably occurs widely in Central America where it may be sympatric with *oblongus* in some areas.

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A NEW SPECIES OF *ACROSTERNUM* FIEBER,  
SUBGENUS *CHINAVIA* ORIAN, FROM CUBA  
(HEMIPTERA: PENTATOMIDAE)

D. A. RIDER

Department of Entomology, Louisiana Agricultural Experiment Station,  
Louisiana State University Agricultural Center,  
Baton Rouge, Louisiana 70803

*Abstract.*—A description is provided for *Acrosternum* (*Chinavia*) *cubensis*, n. sp. New locality records are given for *A. wygodzinskyi* Rolston from Puerto Rico. A key to the eight species of *Acrosternum* known to occur in the West Indies is provided.

The genus *Acrosternum* Fieber, 1860, belongs to the group of pentatomine genera having on the ventral surface of the second visible abdominal segment an anteriorly directed spine or tubercle which is unapposed by an elevated metasternum. Such genera occurring in the Western Hemisphere are keyed by Rolston and McDonald (1981).

The New World species of *Acrosternum*, subgenus *Chinavia* Orian, 1965, were recently revised by Rolston (1983). Rider and Rolston (1986) described 3 new species of *Acrosternum* from Mexico and provided a key to the species occurring in Mexico. Also, the previously unknown male of *A. istum* Rolston was described by Rider (1986). Since the revision by Rolston, an undescribed species has been discovered from Cuba. A key is provided here for the identification of species of *Acrosternum* occurring in the West Indies.

KEY TO WEST INDIES SPECIES OF *ACROSTERNUM*

- 1. Abdominal spine projecting past middle of mesocoxae ..... 2
- Abdominal spine not reaching beyond anterior margin of metacoxae ..... 3
- 2(1). Lateral margins of head black; each humeral angle rounded, not produced laterally beyond base of corium (Jamaica; Cayman Island) ..... *sparnium* (Dallas)
- Lateral margins of head reddish-yellow; each humeral angle right-angular, produced laterally beyond base of corium by more than half the width of an eye (Hispaniola) ..... *insulani* Rolston
- 3(1). Each ostiolar ruga extending only 0.5–0.6 distance from mesial margin of ostiole to lateral margin of thorax ..... 4
- Each ostiolar ruga extending 0.7–0.8 distance from mesial margin of ostiole to lateral margin of thorax ..... 6
- 4(3). Abdominal tubercle reaching middle of metacoxae; each spiracle unattended by a yellow callus (Bahama Islands) ..... *euri* Rolston
- Abdominal tubercle barely attaining posterior limit of metacoxae; each spiracle located on or near a conspicuous yellow callus ..... 5
- 5(4). Proximal ends of tibiae green; each spiracle located just outside posterolateral margin of yellow callus (Fig. 5); rostrum reaching beyond middle of metacoxae (Cuba) ...  
..... *cubensis*, n. sp.

- Proximal ends of tibiae crimson; each spiracle located within posterolateral margin of yellow callus (Fig. 6); rostrum not reaching anterior margin of metacoxae (southern Mexico into Panama; Hispaniola) ..... *montivagum* (Distant)
- 6(3). Abdominal tubercle barely attaining posterior limit of metacoxae (Hispaniola; South America; Galapagos Islands) ..... *ubicum* Rolston
- Abdominal tubercle reaching middle of metacoxae ..... 7
- 7(6). Connexiva with black macule at each posterolateral angle confined to edge of sternite, not expanding onto laterotergite (Fig. 7); each spiracle usually surrounded by a distinct yellow spot (Virgin Islands; Puerto Rico) ..... *wygodzinskyi* Rolston
- Connexival spots at least on basal segments expanding onto laterotergites (Fig. 8); each spiracle unattended by yellow spot (southwestern United States to northern South America; Florida to Guadeloupe) ..... *marginatum* (Palisot de Beauvois)

*Acrosternum (Chinavia) wygodzinskyi* Rolston

Fig. 7

*Acrosternum (Chinavia) wygodzinskyi* Rolston, 1983:142–144, figs. 124–127.

In his revision of *Acrosternum*, Rolston described *A. wygodzinskyi* from St. Thomas and St. John Islands in the Virgin Islands, West Indies. Since this revision, a series of *A. wygodzinskyi* has been collected from Puerto Rico. The label data is "PUERTO RICO: Guanica For., Hwy 333 nr. Playa Tamarindo 27-V-1986, E. G. Riley & D. A. Rider" (13♀, 5♂) and "PUERTO RICO: Guanica Forest, Hwy 334 at Ranger Sta. 28-V-1986, E. G. Riley & D. A. Rider" (23♀, 1♂).

*Acrosternum (Chinavia) cubensis*, new species

Figs. 1–5

*Description.* Dorsum medium green, except head, anterior one-third of pronotum, and anterior two-thirds of scutellum dark green; a few pale-yellow spots on interstices between punctures on coria and scutellum. Anterolateral margin of pronotum and margin of head pale yellow, apex of tylus fuscous. Dorsal punctation dense, dark-green. Venter pale yellow, punctures green. Length excluding hemelytral membrane 11.2 mm.

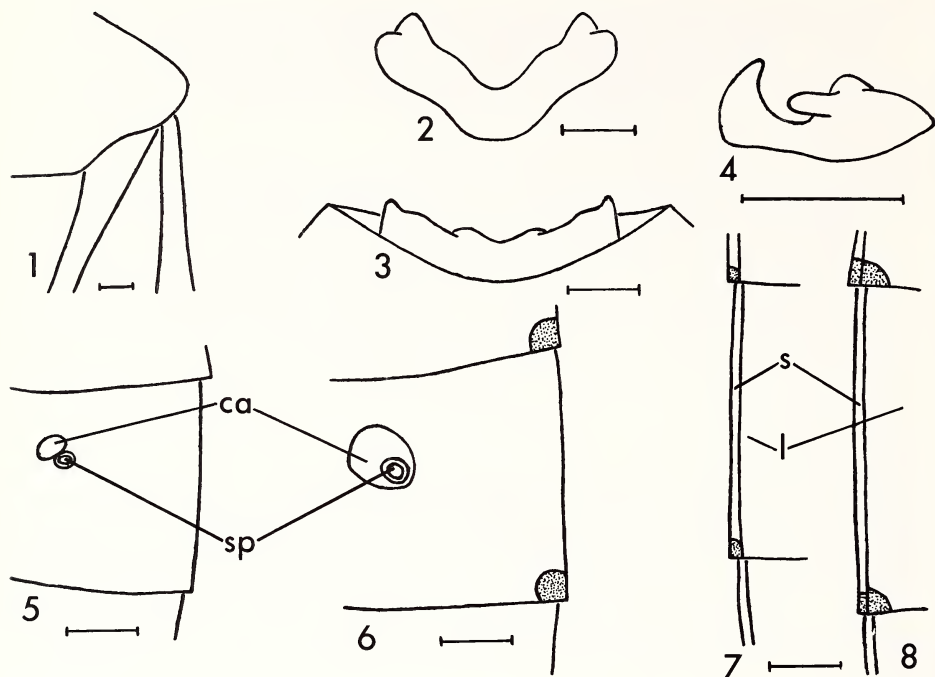
Head narrowly rounded apically; lateral margin of each juga sinuous, nowhere parallel. Length of head 2.1 mm, width across eyes 2.6 mm. Each antenna with segment 1 green; segments 2 and 3 dark violet-brown; segment 4 pale green except basal one-sixth violet-brown; segment 5 pale yellow-brown; distal one-half of segment 3 and segments 4 and 5 distinctly pilose; length of segments 1–5 about 0.4, 1.0, 1.2, 1.7, 1.7 mm.

Pronotum 6.9 mm wide across humeri, mesial length 2.2 mm. Each humeral angle narrowly rounded, almost angular, distinctly produced beyond base of corium, but by less than half the width of an eye (Fig. 1). Anterolateral margin of pronotum straight. No black on cicatrices.

Scutellum 4.3 mm wide at base, 4.8 mm long, with 5 equally spaced white spots along base. No black on basal corners of scutellum. Corium rounded apically, reaching beyond middle of sixth (fifth visible) abdominal segment. Connexivum pale green, no black on posterolateral angles.

Rostral segments 2–4 about 1.4, 1.1, 0.8 mm, ventral surface with median black





Figs. 1-8. 1-5. *A. cubensis*. 1. Humeral angle, dorsal view. 2. Pygophore, caudal view. 3. Pygophore, ventral view. 4. Paramere. 5. Abdominal venter. 6. *A. montivagum*. Abdominal venter. 7. *A. wygodzinskyi*. Connexival markings. 8. *A. marginatum*. Connexival markings. Symbols: callus (ca); laterotergite (l); edge of sternite (s); spiracle (sp). Dimensional lines equal 0.5 mm.

line bordered on both sides by crimson, apex of segment 4 black, terminating near posterior margins of metacoxae. Abdominal tubercle compressed, barely reaching posterior margins of metacoxae. Each ostiolar ruga extending about one-half distance from mesial margin of ostiole to lateral thoracic margin. Posterolateral angle of each sternite pale yellow. Each spiracle pale brown, located just outside posterolateral margin of distinct yellow callus (Fig. 5). Legs green, except coxae pale yellow, and some fuscous markings on tarsi.

Posterior margin of pygophore from ventral view sinuous, broadly and shallowly U-shaped, posterolateral angles prominent (Fig. 3); from caudal view distinctly sinuous, deeply U-shaped, biconical laterally (Fig. 2). Paramere as in Figure 4. Female not known.

*Distribution.* Cuba.

*Holotype.* ♂, labeled "CUBA, Guantanamo Bay Naval Base, Caravella Point, 2-IV-73, blacklight trap/H. M. Westbrook Coll." Deposited in the National Museum of Natural History, Washington, D.C. No paratypes.

*Comments.* In the revision by Rolston (1983), *A. cubensis* will key to couplet 32 containing *A. simplicis* Rolston and *A. euri* Rolston. *Acrosternum cubensis* can be

separated from these two species and all other New World congeners except *A. australe* Rolston by the spiracle-callus arrangement. *Acrosternum australe* and *A. cubensis* are the only two New World species with each spiracle located just outside the posterolateral margin of a distinct, yellow callus. *Acrosternum cubensis* can be separated from *A. australe* by the ostiolar rugae, which extend only about half the distance from the mesial margin of the ostiole to the lateral thoracic margin; the more prominent humeri; the pale-brown spiracles; and the green scutellar apex. *Acrosternum australe* is known only from northern Argentina.

#### ACKNOWLEDGMENTS

I would like to thank R. M. Baranowski (University of Florida, Tropical Research and Education Center, Homestead) for the loan of the specimen on which this description was based. I would also like to thank J. B. Chapin, J. A. Moore, and L. H. Rolston (Louisiana State University) for reviewing an early draft of the manuscript.

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THE GENUS *PHYLLOPHAGA* HARRIS, 1826  
(COLEOPTERA: SCARABAEIDAE) IN CUBA.  
IV. DESCRIPTIONS OF SIX NEW SPECIES

MIGUEL GARCIA-VIDAL

853 Arguello Boulevard, San Francisco, California 94118

*Abstract.*—Six new species of *Phyllophaga* from Cuba are described and SEM micrographs of the male genitalia are given.

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This paper is the fourth of the series about the genus *Phyllophaga* in Cuba. Six new species are described and figures of the male genitalia are given.

I wish sincerely to thank Dr. Alan Hardy, from the California Department of Food and Agriculture in Sacramento for the pictures of the genitalia and all his help and support.

***Phyllophaga villaclarensis*, new species**

Figs. 6, 12

*Description.*—MALE. Submedium in size, length 15 mm. Elytra, sides of pronotum, legs reddish brown; head, disc of pronotum dark brown; underparts yellowish brown. Clypeus coarsely, densely punctured, margins abruptly reflexed; median indentation shallow, angulate; clypeofrontal suture conspicuous. Frons coarsely punctured with small punctures; base impunctate. Pronotum less densely coarsely punctured, with larger punctures, umbilicate; anterior, posterior margins entire; lateral margins subcrenulate; sides medially, broadly dilate; anterior angles acute, posterior obtuse. Scutellum punctured on sides; disc impunctate. Elytra less densely punctured than pronotum; punctures smaller but larger than on head; sutural margin tumid. Pygidium almost triangular, with sparse, small, shallow punctures; apex narrowly rounded. Antennal club trisegmented, longer than funicle or clypeus at middle. Prothibia tridentate; upper tooth distant from others; distal elongate; 3 or 4 anterior tarsal segments toothed internally apically. Coxal plates with long, erect, thick hairs. Sternites pubescent, with long, straight hairs. Urosternites scarcely punctured, small punctures, with some straight, fine hairs; last segment transversally grooved. Longer calcar of metatibia slender, acuminate, longer than first tarsal segment. Claws slightly curved; lower tooth distinctly shorter than upper tooth, at most slightly more than one-half as long.

*Holotype.* ♂, Las Villas, Cienaga de Zapata, Cuba, collector F. de Zayas, May 1959. Deposited in Illinois State Natural History Survey Division, Champaign, Illinois (ISNHSD).

*Notes.* The name of the species refers to the Villaclara province, where it was collected.

The aedeagal sheath is without a fringe of minute teeth. This species belongs to the *baracoana* subgroup.

**Phyllophaga santiaguensis**, new species

Figs. 1, 7

*Description.* MALE. Small, length 11–12.5 mm, shining. Head dark brown; body yellowish brown to light reddish brown. Clypeus densely punctured; margins broadly reflexed; median indentation shallow, subangulate. Frons punctured as clypeus; base impunctate. Pronotum less densely punctured than head, with larger punctures; anterior, posterior margins entire; anterior half of lateral margins subcrenulate; sides broadly dilate medially; anterior angles slightly obtuse, posterior rounded. Scutellum punctured laterally, disc impunctate. Elytra more densely punctured than pronotum but less than head; punctures smaller than on pronotum; sutural margins tumid. Pygidium punctured as elytra, but punctures shallower; apex broadly rounded. Antennal club trisegmented, much longer than funicle. Protibia tridentate, upper tooth distant from median; distal elongate. Sternites, especially mesosternite, densely pubescent, with long, fine, erect hairs. Urosternites less densely punctured than sternites, with a few short, fine, erect hairs; last segment transversally grooved. Longer calcar of metatibia acuminate, twice as long as first tarsal segment. Claws gently curved, upper tooth elongate, fine, about twice as long as lower.

*Holotype.* ♂, Ciudadamar, Santiago de Cuba, Oriente, June 1954, collector Zayas. Deposited in ISNHSD.

*Paratypes.* 4 ♂♂, same data as holotype, deposited in ISNHSD. 1♂, Ciudadamar, Santiago de Cuba, Oriente, Cuba, June 1954, collector Zayar-Alayo, in California Academy of Sciences, San Francisco (CAS).

*Notes.* The name of the species refers to Santiago de Cuba, where it was collected.

This species is so close to *P. marinus* that it is almost impossible to differentiate them on external characteristics, except for the lateral margins of the pronotum, which are subcrenulate in *P. santiaguensis*, the antennal club is longer and the aedeagi are totally different.

**Phyllophaga marinus**, new species

Figs. 2, 8

*Description.* MALE. Small, length 11 mm, shining. Head brown, body yellowish brown. Clypeus densely, coarsely punctured, punctures of different sizes; margins moderately reflexed; median indentation almost obsolete, subangulate. Frons punctured about as clypeus, base impunctate. Pronotum less densely punctured than head, but punctures larger; margins entire, sides broadly dilated medially; anterior angles slightly obtuse, almost straight, posterior obtuse. Scutellum triangular, punctures on sides, disc impunctate. Elytra more densely punctured than pronotum but less than head; punctures smaller than on pronotum; sutural margins conspicuous, moderately tumid. Pygidium punctured about as elytra; apex subtruncate with some long, fine erect hairs. Antennal club trisegmented, longer than funicle. Protibia tridentate; teeth equidistant, apical elongate; anterior tarsal segments not toothed internally. Coxal plates with a few long, erect, thick hairs. Sternites, especially mesosternites, densely, finely punctured with fine, long, erect hairs. Urosternites scarcely punctured; posterior half of last segment transversally grooved. Longer calcar of metatibia almost twice as long as first tarsal segment. Claws slightly curved; upper tooth fine, elongate, about twice as long as lower.



*Holotype*. ♂, Ciudadamar, 27 Oct. 1946, collector unknown. In ISNHSD.

*Notes*. The name of the species refers to area of Ciudadamar, in Santiago de Cuba, where it was collected.

In addition to the differences mentioned before, this species differs from *P. santiaguensis* in that the base of prothorax and base of elytra are equal in width and that the anterior tarsal segments are not toothed, as in *P. santiaguensis*. The sheath of the aedeagus is evenly rounded on its apical margin and the apex of the paramere is double angled.

### ***Phyllophaga potrerillo*, new species**

*Description*. MALE. Medium sized, length 14.5–16 mm, piceous. Clypeus densely, finely punctured; margins broadly reflexed; median indentation angulate, deep; clypeo-frontal suture conspicuous. Frons punctured as clypeus; base impunctate. Pronotum more sparsely, coarsely punctured than head, but punctures larger; sides broadly dilated medially; anterior half of lateral margins subcrenulate; anterior, posterior margins entire; anterior angles acute, posterior nearly rectangular. Elytra more densely punctured than pronotum but less than head; punctures smaller than on pronotum; sutural margin tumid. Scutellum punctured as elytra but disc impunctate. Pygidium more densely punctured than elytra but punctures shallower; apex broadly rounded, with fine, long, erect hairs on margin. Antennal club trisegmented, about as long as four preceding segments. Protibia tridentate; upper tooth almost obsolete, median triangular, distal elongate. Coxal plates with some thick, reflexed hairs. Sternites densely pubescent with long hairs. Urosternites densely, finely punctured, with a few long, thick hairs, especially on fifth segment; last segment transversely, posteriorly grooved. Longer calcar of metatibia acuminate, slender, about  $1\frac{1}{3}$  length of first tarsal segment. Claws moderately curved, lower tooth very small, upper slender, about twice as long as lower.

*Holotype*. ♂, Pico Potrerillo, Las Villas, July 1955, collector F. de Zayas. Deposited in ISNHSD.

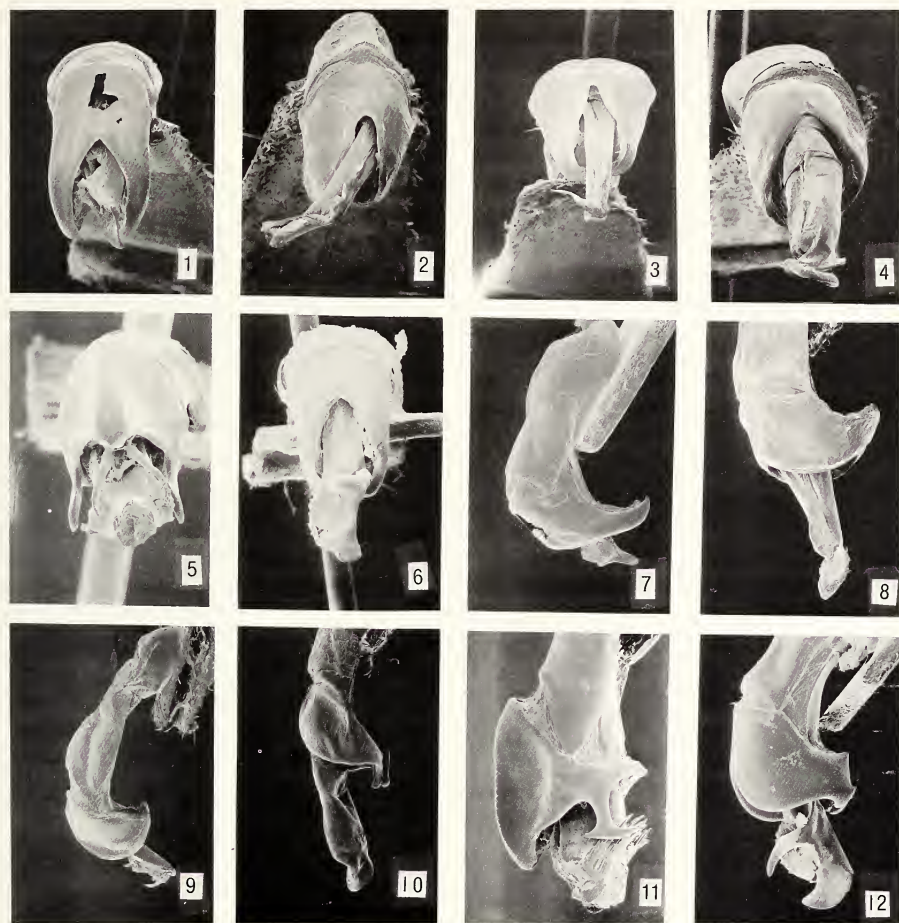
*Paratype*. Collector Alayo (no other labels), in CAS.

*Note*. The name refers to Pico Potrerillo, where it was collected.

### ***Phyllophaga pilotoensis*, new species**

Figs. 4, 10

*Description*. MALE. Submedium in size, length 14–15 mm, shining. Head dark brown; body, underpart light reddish brown. Clypeus densely, coarsely punctured; margins broadly reflexed; median indentation moderately deep; clypeo-frontal suture conspicuous. Frons punctured as clypeus, base impunctate; median line present. Pronotum less densely punctured than head, but punctures larger, deeper; anterior, posterior angles entire; sides broadly dilated medially; first half of lateral margins subcrenulate; anterior angles slightly obtuse, almost rectangular, posterior obtuse; some reflexed thick, long hairs from under sides. Scutellum semi-circular, punctured on sides about as on pronotum, but disc impunctate. Elytra more densely punctured than pronotum; sutural margins tumid. Pygidium finely, densely punctured; margin with erect, fine hairs; apex subtruncate. Antennal club trisegmented, about as long



Figs. 1-12. 1-6. Frontal view of aedeagus of six new *Phyllophaga* species. 1. *P. santiaguensis*. 2. *P. marinus*. 3. *P. potrerillo*. 4. *P. pilotoensis*. 5. *P. trinitariensis*. 6. *P. villaclarensis*. 7-12. Lateral view of aedeagus of six new *Phyllophaga* species. 7. *P. santiaguensis*. 8. *P. marinus*. 9. *P. potrerillo*. 10. *P. pilotoensis*. 11. *P. trinitariensis*. 12. *P. villaclarensis*.

as funicle. Protibia tridentate, median tooth stouter than distal. Sternites, especially mesosternite, densely pubescent, with erect, long, fine hairs. Urosternites less densely pubescent; hairs shorter, except for a tuft of long hairs on sides of fifth segment; posterior part of last segment transversely grooved. Longer calcar of metatibia 1½ times as long as first tarsal segment. Claws moderately curved, lower tooth stouter than upper.

*Holotype*. ♂, Moa, Oriente, 13-22 April 1945, collector J. Acuna. In ISNHSD.

*Paratypes*. 1♂, Batey de Moa, Oriente, Cuba, June 1954, collector Zayas-Alayo, in ISNHSD. 1♂, Piloto, Moa, Oriente, Cuba, June 1954, collector Zayas-Alayo, in CAS.

*Notes.* The name refers to Piloto, one of the locations where it was collected.

This species is close to *P. dubitatus* Garcia, but is unicolorous; the upper margins of the paramere are without minute spines, the aedeagal sheath is not auriculate and the aedeagal process consists of finely spinose ridges.

***Phyllophaga trinitariensis*, new species**

Figs. 5, 11

*Description.* MALE. Small, length 10 mm, shining. Elytra, underparts light brown; pronotum, scutellum, sutural margins, reddish brown; head piceous; legs yellowish brown. Clypeus densely, coarsely punctured; margins abruptly reflexed; median indentation shallow, subangulate. Frons coarsely punctured, less densely toward clypeus. Pronotum less coarsely, densely punctured, but punctures slightly larger; anterior margins entire; basal margin with a row of coarse punctures; anterior, basal angles obtuse; sides rounded, dilated medially. Scutellum with rows of punctures. Elytra punctured about as pronotum, but punctures slightly smaller; sutural margins tumid. Pygidium absent. Antennal club trisegmented, about as long as funicle. Protibia tridentate, upper tooth very small, distant from others; distal stouter, longer than median. Sternites finely, densely punctured. Coxal plates scarcely punctured, with a few short, thick erect hairs. Urosternites slightly less densely punctured, punctures smaller. Longer calcar of metatibia fine, acuminate about twice length of first tarsal segment. Claws strongly curved; upper tooth finer, longer than lower.

*Holotype.* ♂, collector F. de Zayas, from Topes, Lomas de Trinidad, Las Villas, Cuba, 1959, in ISNHSD.

*Notes.* The name refers to Trinidad, where it was collected.

The base of paramere is emarginate, the dorsal aedeagal paired processes are slender, convergent at middle then divergent from inside, and the medial aedeagal process with single row on each side of lateral spines which extend well on to sides of sheath.

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THE FIRST NORTH AMERICAN RECORDS OF  
*HIPPODAMIA VARIEGATA* (GOEZE)  
(COLEOPTERA: COCCINELLIDAE)

ROBERT D. GORDON

Systematic Entomology Laboratory, BBII, Agricultural Research Service, USDA,  
% U.S. National Museum of Natural History, Washington, D.C. 20560

**Abstract.**—*Hippodamia variegata* (Goeze), an Old World member of the tribe Coccinellini, is recorded as established in North America in the vicinity of Montreal, Quebec, Canada. Identification characteristics are given and its relationship to native North American species is discussed.

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Specimens of *Hippodamia variegata* (Goeze) were collected in the vicinity of Montreal, Quebec in 1984 by 2 different collectors. This species, mainly Palaearctic in distribution, also occurs in Africa and India. This publication documents the establishment of *H. variegata* in Canada and presents pertinent information concerning its identification in the North American fauna.

I thank T. J. Henry, Systematic Entomology Laboratory; N. Vandenberg, Berkeley, California, R. Sailer, University of Florida, Gainesville; and J. Chapin, Louisiana State University, Baton Rouge, for reviewing the manuscript.

*Hippodamia variegata* (Goeze)

*Coccinella variegata* Goeze, 1777:247.

*Adonia variegata*: Mulsant 1846:39; Korschefsky, 1932:346.

*Hippodamia* (*Adonia*) *variegata*: Khnzorian, 1982: 326.

*Hippodamia variegata*: Gordon, 1985:706.

**Diagnosis of the North American population.** Length 4.40 to 5.0 mm, width 3.0 to 3.25 mm. Pronotum with fine, raised margin at base. Head yellow with vertex black (male) or yellow with vertex and large frontal spot black (female). Pronotum black, with anterior and lateral borders and small spot on each side of middle yellow (female) or with anterior border of black area deeply emarginate medially with yellow and spot on each side of middle broadly connected to yellow anterior border (male). Elytron orange with 5, 6, or 7 black spots; scutellar, posthumeral, 2 postdiscal, and apical spot constant, either or both humeral and postscutellar spots often absent. Ventral surface black except propleuron and meso- and metepimera yellow, tibia often yellow or partially so.

**Remarks.** *Hippodamia variegata* is not included in the key to the species of North American *Hippodamia* (Gordon, 1985). That key should be modified by inserting an additional couplet at the beginning of the key as follows:

1. Pronotum with fine raised margin at base ..... *variegata* (Goeze)
- Pronotum without raised margin at base ..... 2



Without this modification *H. variegata* keys to couplet 31 (p. 709) which includes *H. convergens* Guerin and *H. glacialis glacialis* (F.). The strongly convergent pale spots on the pronotum as well as the lack of a raised basal pronotal margin will distinguish *H. convergens*, the most similar appearing species in the North American fauna, from *H. variegata*. *Hippodamia glacialis* lacks a black scutellar spot, and the 2 postdiscal spots on the elytron are usually united to form an irregular, transverse band. *Hippodamia variegata* has a black scutellar spot, and the postdiscal spots are not united in any North American specimen examined. It should be noted that the sexual dimorphism noted above is not consistent in Old World populations of *H. variegata*. The males always have a tendency to have more extensive areas of yellow pigmentation, but it is often not as distinct a sexual difference as it apparently is in the North American population.

This species has been placed in the genus *Adonia* by authors beginning with Mulsant (1846). Khnzorian (1982) considered *Adonia* a subgenus of *Hippodamia* (this reference should be consulted for information on synonymy), and Gordon (1985) considered *Adonia* a synonym of *Hippodamia*.

The North American specimens are most similar to those occurring naturally in France. Specimens from northern and eastern Europe usually have the elytral ground color a darker orange with black spots more pronounced than in North American specimens; specimens from the Mediterranean Region are usually very pale with reduced markings; and the Indian and African populations tend to have the elytral spots large and often coalesced. Dobzhansky (1933) or Hodek (1973) should be consulted for further details on the geographical variation exhibited by this species. The larva was described and illustrated in Hodek (1973).

The first North American specimens of *H. variegata* were sent to me by Claude Chantal, St-Nicolas-est, Quebec, and additional specimens by Jean MacNamara, Biosystematics Research Institute, Ottawa, Ontario. Data taken from the specimens examined are: 6 specimens, Granby, Shefford (vicinity of Montreal), 4-V-1984, 4-VI-1984, 18-V-1984, 21-VI-1984, JF Roch; 2 specimens, Mont-Royal, Montreal, 27-VIII-1984, une clariene, L. Lesage; 1 specimen, St-Hilaire, Rouville (vicinity of Montreal), 10-VI-1984, JF Roch; 2 specimens, Dorval, 11-IX-1985, Lesage & Smetana, in abandoned field; 2 specimens, Dorval, 29-VIII-1985, Lesage & Smetana, abandoned field.

*Hippodamia variegata* may be truly adventive rather than the result of an intentional introduction. Hamilton (1894) reported a doubtful record of this species from Nova Scotia, but this has been considered erroneous (Brown and de Ruelle, 1962), and no confirming records have been found for 90 years despite relatively intense field surveys. A parallel exists with *Propylea quatuordecimguttata* (L.), which is also established in the vicinity of Montreal as first reported by Chantal (1972). The reasons for 2 species of Old World Coccinellini becoming established in the same area, apparently without intentional releases, are unknown. I suspect that they were, in fact, intentionally released but no report was filed. There were numerous intentional introductions of *H. variegata* into various portions of the United States from 1957 to 1983 which apparently did not result in establishment of the species (Gordon, 1985). However, no records of introductions into Canada have been found.

Members of *Hippodamia* are generally regarded as aphid predators, and Hodek

(1973) records 4 species of aphids as essential foods of *H. variegata*. If the present populations of this species spread and their population density increases, they could aid in the suppression of aphids in some areas.

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**DIURNAL PREDATION ON ROOSTING BUTTERFLIES DURING  
INCLEMENT WEATHER: A SUBSTANTIAL SOURCE OF  
MORTALITY IN THE BLACK SWALLOWTAIL,  
*PAPILIO POLYXENES* (LEPIDOPTERA: PAPILIONIDAE)**

ROBERT C. LEDERHOUSE,<sup>1</sup> SYLVIO G. CODELLA,<sup>2</sup> AND PAUL J. COWELL<sup>3</sup>

Department of Zoology and Physiology, Rutgers University,  
Newark, New Jersey 07102

*Abstract.*—To investigate the effect of inclement weather on mortality in adult butterflies, black swallowtails were tethered to typical night roosts and monitored during favorable and adverse weather periods. Fair weather mortality averaged less than 10%, yet mortality during weather-prolonged roosting was about 35%. This significant difference was primarily due to increased predation during daylight periods. Starvation was restricted to older butterflies since freshly-emerged individuals could survive 7 or more days without feeding. Vertebrates, particularly birds, accounted for 65% of the predation. Predators attacked the sexually dimorphic males and females equally which supports the role of the more similar ventral patterns in effective mimicry. Predators showed no preferences for individuals roosting on living or dead roosts. Predation on roosting individuals is probably a primary source of mortality for many butterfly species, especially when inclement weather forces individuals to extend roosting during daylight periods.

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Adverse weather has been implicated as a significant source of mortality in a number of butterfly populations (Ehrlich et al., 1972, 1980; Shapiro, 1979; Calvert et al., 1983; Lederhouse, 1983). Death may result directly from exposure to severe conditions (Calvert et al., 1983), but this increased mortality has more commonly been correlated with reduced larval or adult resources (Ehrlich et al., 1972, 1980; Singer, 1972) or prolonged periods of predatory risk (Lederhouse, 1983). In cold weather, exothermic butterflies have reduced ability to avoid or escape attacks by predators (Brown and Neto, 1976; Bowers et al., 1985). Also, birds may forage more during periods of adverse weather (Brower and Calvert, 1985). Mechanisms by which adverse weather actually produces increased mortality remain largely unclear.

Lederhouse (1983) documented shorter average longevity of male black swallowtail butterflies correlated with periods of unfavorable weather. Mortality of adults is highest while roosting (Rawlins and Lederhouse, 1978). In this paper, we report the results of experiments which clearly determine the relative importance of exposure, starvation and predation as sources of weather-related mortality on roosting black swallowtails.

**MATERIALS AND METHODS**

Black swallowtail butterflies typically search for a roost about 2 hr before sunset. They bask on the roost until decreasing sunlight and temperature trigger a roosting posture with the wings dorsally appressed. This posture is maintained throughout the night. The butterflies bask again in the morning as soon as direct sunlight reaches

them (Rawlins and Lederhouse, 1978). They continue to bask until their thoracic temperatures reach or exceed 24°C; they are then able to fly (Rawlins, 1980). If ambient temperatures remain below 24°C with little or no solar radiation, black swallowtails cannot fly to escape predators that discover them during the extended roosting period.

Chilled, well-fed black swallowtails were placed on typical evening roosts (Rawlins and Lederhouse, 1978) just prior to sunset (Bishop, 1984) at early successional field locations in Great Swamp National Wildlife Refuge, Morris County, New Jersey. A natural population of *P. polyxenes* was observed in this area, and during a pilot trial wild individuals roosted on perches within the study area that were similar to those chosen for the experiments. Males and females were placed on both living and dead roost plants in equal proportions and in a random sequence. Roosts were generally 5 m apart and arranged in a semicircle to aid observation. An inconspicuous blue flag was placed at the base of each roost to facilitate relocation. Goldenrod (*Solidago* spp.) was the roost most frequently utilized for experiments because of its abundance.

All subjects were checked at dawn the following day. Damaged and dead individuals were removed as discovered, and a thorough search was made for remains of any missing butterflies. The butterflies were checked again when the sun had fully risen (e.g., 0700 hr EST in mid-July) and for a final time at the onset of favorable flight conditions (Rawlins, 1980). The setup was then dismantled. Periods of inclement weather, with reduced temperature and solar radiation, extended the roosting period into the afternoon and at times into the next day. In the latter case, the butterflies were checked again at sunset and likewise at sunrise on the following day, and finally when the weather cleared.

All butterflies were secured to their roosts by means of tethers which prevented escape without inhibiting normal wing postures (Brower, 1959). Each consisted of a short black cotton thread "harness" looped around the bases of the wings and tied to a 10 cm leader of monofilament. The leader was fastened to a 3 cm "alligator clip" which in turn was clamped to the roost stem. The tethers offered several advantages. They aided in the retrieval of predatory remains and eliminated losses due to strong winds (R. C. Lederhouse, pers. obs.) or unexpected flight from warmer microhabitats. In such instances, absence from the roost would have been misinterpreted as evidence of predation. Tethered butterflies could not escape attacks through crawling or falling off the roost, although Shapiro (pers. comm.) observed high rates of predatory attack on butterflies removed from night roosts and placed on the ground. Since all trials were terminated when flight temperatures were attainable, all acts of predation were realistic within the context of the experimental design. Because tethers were used in all cases, comparisons between experimental treatments should be valid even if actual rates of predation were altered.

After the experiments, all butterflies were classified into one of five mutually exclusive categories. Alive and undamaged individuals showed no ill effects from the experiment and were frequently used in subsequent trials. Alive but damaged butterflies showed evidence of predator harassment. Dead but undamaged butterflies were assumed to have resulted from advanced age or exposure to weather. Dead and damaged individuals resulted from predation; body remnants (wings, abdomen, etc.) were found. Missing butterflies were not attached to the harness, and no remains were located.



Table 1. Fates of tethered *P. polyxenes* in relation to weather for 1984 and 1985. All fates are given as percentages of individuals for an entire trial regardless of duration.

	1984		1985	
	Fair weather	Inclement weather	Fair weather	Inclement weather
Trials (N)	12	6	5	4
Individuals (N)	217	96	76	58
Alive/undamaged	99.0	64.6	88.2	67.2
Dead/undamaged	0.5	6.3	4.0	5.2
Total predation	0.5	29.1	7.9	27.6
Alive/damaged	0.5	1.0	2.6	1.7
Dead/damaged	0	20.8	4.0	20.7
Missing	0	7.3	1.3	5.2

The only categories that could possibly be confused were the dead but undamaged and the dead and damaged groups. Predators such as spiders or sucking insects could kill and feed on butterflies without producing easily detectable damage. Occasionally, predators might scavenge already dead individuals. Such possible confusion was limited by the frequency of field checks and careful examination of carcasses. Preliminary tests of tether reliability showed that individuals could not free themselves. Thus, missing butterflies must have been removed by predators.

A portable bird blind was used to facilitate the observation of predation. In the majority of instances, however, the type of predator was inferred from the damage suffered by the butterfly. Examples of typical bird damage were observed during concurrent experiments with caged blue jays, *Cyanocitta cristata* (Codella and Lederhouse, in manuscript). In addition to the beak marks routinely used to verify bird damage (e.g., Carpenter, 1933; Collenette, 1935; Sargent, 1973; Shapiro, 1973; Edmunds, 1974; Bowers and Wiernasz, 1979), avian attacks produced intact wings, often associated with disarticulated legs or antennae, and wing fragments split cleanly along veins. Beak marks were noted on only a fraction of the wings of butterflies eaten by the jays. The severing of an abdomen from the thorax likely resulted from the constricting of a tether when a strong predator (a vertebrate) pulled at a butterfly. An alternate explanation for this is mishandling by a predator, which was also observed among the aviary birds. It is assumed that all missing butterflies resulted from vertebrate predation. No invertebrate could break the tethers, and very meticulous searches reduced the likelihood of overlooked remains.

Invertebrate damage was characterized by wings (whole or fragmented) with chewed edges, carcasses with punctures or holes in the eyes or abdomen, and partially consumed bodies with fragments of cuticle adhering to the remains. Observed invertebrate attacks resulted in similar damage.

To determine the duration that starved *P. polyxenes* could live, newly-emerged adults were placed in individual cages in two controlled temperature chambers at either 15 or 20°C. These temperatures are typical of those during roosting but too low for adult flight and feeding without supplemental radiation (Rawlins, 1980). The butterflies spent the majority of time perched at these temperatures and were checked daily until all had died.

Table 2. Longevity of starved *Papilio polyxenes* at two temperatures. Values are in days  $\pm$  one standard deviation. The probability of a larger  $t$  under the  $H_0: t = 0$  is given.

Sex	N	15°C	P	N	20°C
Male	20	7.8 $\pm$ 1.9	ns	18	7.2 $\pm$ 1.2
		P < 0.05			ns
Female	14	12.1 $\pm$ 4.2	0.01	8	7.5 $\pm$ 1.3

## RESULTS

The mortality of roosting black swallowtail butterflies was considerably higher during periods of unfavorable weather in both 1984 and 1985. In 1984, only 1.0% of the individuals exposed for a typical fair-weather overnight roosting period died or were attacked by predators. However, 35.4% of those exposed for a prolonged period due to inclement weather died or were attacked. In 1985, death and damage during a typical overnight was 11.9%. This compares with 32.8% for extended roosting periods in 1985 (Table 1). In both years the differences were significant ( $\chi^2$ ,  $2 \times 2$  contingency table: 1984,  $P < 0.001$ ; 1985,  $P < 0.01$ ).

Dead but undamaged individuals accounted for only 19.4% of the total mortality in 1984 and 21.4% in 1985. Invariably, these individuals were old and frequently had been used in several trials. Although it is difficult to differentiate between exposure and starvation, 84.6% of these deaths occurred during the first night, which suggests exposure.

In our laboratory test of starvation, freshly emerged *P. polyxenes* survived five or more days without feeding (Table 2). Females survived significantly longer than males at 15°C ( $t$ -test,  $P < 0.05$ ) but only slightly longer at 20°C. Both sexes survived longer at 15°C than 20°C. This difference was significant for females ( $t$ -test,  $P < 0.01$ ). Since overnight and inclement day temperatures were often less than 15°C, these results indicate that starvation in itself may only be a factor for very old butterflies.

Predation was the greatest cause of mortality of roosting black swallowtails. In 1984, 0.5% of fair weather roosting black swallowtails were preyed upon, compared with 29.1% of butterflies roosting under adverse conditions. A similar comparison for 1985 shows an increase from 7.9% to 27.6%. In both years the differences were significant ( $\chi^2$ ,  $2 \times 2$  contingency table: 1984,  $P < 0.001$ ; 1985,  $P < 0.01$ ). Part of these differences was due to the longer period at risk during inclement weather. However, the predation rate per hour of exposure was higher during inclement weather in both years (Table 3).

Predation on roosting black swallowtails occurred predominantly during daylight

Table 3. Rates of predation on roosting *P. polyxenes*. Values are predation events per hour at risk.

Year	Fair weather	Inclement weather
1984	0.006	0.162
1985	0.093	0.112

Table 4. Predation on roosting *Papilio polyxenes* by time of day in relation to risk. There were 7 predation events during 218.7 hr at risk in fair weather and 28 during 315.6 hr of inclement weather where the time of day could be accurately determined.

Time	Fair weather			Inclement weather		
	% of predation	% of exposure	Rate per hr	% of predation	% of exposure	Rate per h
Night	42.9	77.0	0.02	10.7	53.2	0.02
Morning	57.1	23.0	0.08	0	13.0	0
Day	—	—	—	89.3	33.8	0.23

(Table 4). This was true for both fair and adverse weather. However, the primary difference was the substantial loss on inclement days during the period when the butterflies would have been flying had conditions been favorable. Since the daylight exposure period was shorter than the dark exposure period, these differences are accentuated when calculated as rates (Table 4). The rates for the night were almost identical whether the daytime was fair or foul.

Predation rates were highly variable. Although predation during unfavorable weather occurred primarily during daylight, the number of black swallowtails attacked did not correlate with the duration of the daylight period that they were exposed. This held whether the daylight periods over two-day trials were considered separately or summed ( $r = 0.02$  or  $-0.36$ , respectively; neither significant). Predation occurred in all but one trial during inclement weather, with a percent of butterflies attacked ranging from 0 to 100 with a mean of  $29.5 \pm 29.9$ .

Predators attacked roosting male and female black swallowtails equally in both 1984 and 1985 (Table 5). Males were somewhat more likely to die from exposure/starvation than females but not significantly so. Predators attacked butterflies on dead roosts slightly more often than those on living roosts in 1984, but this was not significant. This trend was reversed in 1985 but still not significant. Thus, the combined data gave nearly identical attack rates on butterflies on the two roost types (Table 6). Neither vertebrate nor invertebrate predators attacked black swallowtails preferentially by roost type.

Predators were identified by direct observation in five cases. These included 2 attacks by ants (Formicidae) and one each by a damsel bug (Nabidae), a bald-faced

Table 5. Mortality of tethered, roosting *P. polyxenes* in relation to sex.

	1984		1985	
	Male	Female	Male	Female
N	152	151	54	54
Alive/undamaged	133	136	44	44
Dead/undamaged	4	1	3	2
Total predation (%)	9.9	9.3	13.0	14.8
Alive/damaged	1	1	0	3
Dead/damaged	10	10	4	5
Missing	4	3	3	0

Table 6. Mortality of tethered, roosting *P. polyxenes* in relation to roost type.

	1984		1985	
	Dead	Living	Dead	Living
N	153	150	66	68
Alive/undamaged	132	137	54	52
Dead/undamaged	4	1	4	2
Total predation (%)	11.1	8.0	12.1	20.6
Alive/damaged	1	1	0	3
Dead/damaged	15	5	6	7
Missing	1	6	2	4

hornet (*Vespula maculata*) and a yellow jacket (*V. maculifrons*). In the majority of instances, however, the type of predator was inferred from the damage suffered by the butterfly as indicated in Materials and Methods. Our analysis indicates that birds and possibly other vertebrates performed 64.7% of the predation, and invertebrates were responsible for the remaining 35.3%.

#### DISCUSSION

The results of this experiment demonstrate significantly higher mortality for roosting butterflies during periods of adverse weather. Most of this increase was due to greater predation. Exposure and starvation accounted for only 20% of the increase. Newly-emerged black swallowtails survived a week or more without feeding in our study and Rawlins (1980) demonstrated that young, well-fed individuals can withstand periods of freezing temperatures.

Although a bird blind was used during part of this study to identify individual predators, the only cases observed involved invertebrates. However, by using reasonable assumptions and by comparing remains to those produced by feeding black swallowtails to a variety of known predators, we are fairly confident that vertebrate predators are the major source of predation. The high incidence of beak marks (35.0% of all retrieved remains attributed to vertebrates) and the occurrence of over 80% of all predation during daylight suggest that birds are the major source of vertebrate predation, although one of the overnight losses reported by Rawlins and Lederhouse (1978) was probably due to a skunk (*Mephitis mephitis*).

The actual level of predation in this study may have been influenced by our choice of study areas and individual roosts, the use of tethers, and the density at which the butterflies were placed during the trials. Artificially high densities may have provided the opportunity for traplining by birds. Although these and possibly other factors may have influenced the absolute values, the relative importance of weather, time of day, sex and roost type would be unaffected since each experimental group was treated in the same way.

Although the fair weather rate of predation was very low in 1984, the rate in 1985 was quite similar to the natural loss rate under similar conditions reported by Rawlins and Lederhouse (1978). The 8.0% per night predation loss yields adult longevities typical for fair weather broods (Lederhouse, 1983). Assuming that the average black



swallowtail was confronted by one prolonged roosting period during harsh weather broods, again the life expectancies calculated from predation observed in this study agree quite well with those reported for an unusually inclement period by Lederhouse (1983).

The increased predatory losses during extended roosting periods were not simply due to the longer periods of risk. Rates were lower during the night and higher during daylight. Black swallowtails that roosted during fair weather were relatively safe because 75.0% of the roosting period was in the dark. Individuals forced to remain on the roost because of inclement weather faced the double hardship of prolonged durations and greater conspicuousness during daylight. The unpredictable and sporadic nature of predation is further indicated by concurrent tests with roosting wood nymphs, *Cercyonis pegala* (Satyridae). In one test, none of ten individuals were attacked over the 13 hr of the trial, yet 7 of 10 individuals were attacked within 2 hr 21 min between checks in another trial (Lederhouse and Codella, unpubl. data). Given that insectivorous passerine birds frequently show peaks of foraging shortly after dawn and again in late afternoon, high daytime predation rates for roosting butterflies are not surprising. Jeffords et al. (1980) suggest a late afternoon peak for predation on day-flying males of the moth, *Callosamia promethea* (Saturniidae).

Although roosting black swallowtails demonstrated a preference for dead roosts under natural conditions (Rawlins and Lederhouse, 1978), our data do not support an anti-predator explanation for this behavior. Perhaps the greater stability and relative isolation of such dead roosts decreased the likelihood that an individual would be dislodged by wind or rain. This advantage was difficult to investigate in our study due to the use of tethers.

In New Jersey, the black swallowtail produces two to three broods per summer (Shapiro, 1966, 1974; Lederhouse, 1983). Bad weather typically affects adult butterflies at the beginning of the first brood and the end of the last brood. Therefore, increased mortality during the first brood should be primarily due to increased predation, and the late-season increases should reflect both predation and exposure/starvation losses. The tendency for males to suffer greater exposure/starvation mortality under roosting conditions agrees with the shorter lifespan of starved male black swallowtails. Since males have a lower fat content (Lederhouse et al., 1982), they are probably more dependent on a steady diet of nectar for energy.

Male and female black swallowtails are sexually dimorphic in color patterns. Jane Brower (1958) demonstrated that the black swallowtail is an effective mimic of the aposematic pipevine swallowtail *Battus philenor* (Papilionidae). However, she primarily used females, and thus did not investigate sexual differences. A number of authors (e.g., Remington and Remington, 1957; Waldbauer and Sternburg, 1975; Turner, 1978) state that the male is non-mimetic, but this assumption has not been tested. Rawlins and Lederhouse (1978) suggested that mortality on the roost would select for a mimetic ventral pattern since it is exposed during roosting. Male and female black swallowtails are much more similar in pattern ventrally than dorsally (Rawlins and Lederhouse, 1978). The similar rates of predation on both sexes support these contentions. Since it was inferred that birds did most of the predation during daylight, it is unlikely that the similar predation rates for males and females were significantly influenced by low light levels or the inability to detect colors. The effectiveness of dorsal and ventral color patterns of both sexes in mimicking *B.*

*philenor* has been investigated with caged birds as well as in the field and will be reported in detail at a later time (Codella, 1986; Codella and Lederhouse, in manuscript).

Reports of butterflies being preyed upon while active are scarce (Young, 1971; Davies, 1977). Such acts of predation are probably most successful when the butterfly is distracted by nectaring, puddling, mating or ovipositing (Rawson and Bellinger, 1953; Wright, 1981; Ehrlich and Ehrlich, 1982). Except for a few communal species (Benson and Emmel, 1973; Turner, 1975; Young and Thomason, 1975; Brower et al., 1977), detailed information on the roosting behavior of butterflies is quite limited. The inconspicuousness of roosting individuals and the deliberate nature of their roost search flights suggest that roost choice is under strong selection pressures. Additional studies of *Cercyonis pegala* in New Jersey and of *Battus philenor* and the zebra swallowtail, *Eurytides marcellus* (Papilionidae), in eastern Texas revealed substantial mortality on the roost that was considerably increased during periods of inclement weather (Lederhouse and Codella, unpubl. data). We believe that predation on roosting individuals is a primary source of mortality for many butterfly species. This is particularly so at those latitudes and altitudes where weather causes prolonged roosting during daylight hours. This has implications on the interpretation of proposed cases of aposematism and mimicry, as the warning or mimetic wing surface should be exposed during this high-risk period.

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<sup>1</sup> Present address: Department of Entomology, Michigan State University, East Lansing, Michigan 48824.

<sup>2</sup> Present address: Department of Entomology, University of Wisconsin, Madison, Wisconsin 53706.

<sup>3</sup> Present address: Department of Herpetology, New York Zoological Society, 185th St. and Southern Blvd., Bronx, New York 10458.



**COCHYLIS CAULOCATAX RAZOWSKI  
(LEPIDOPTERA: TORTRICIDAE: COCHYLINI):  
A REDESCRIPTION OF THE MALE WITH NEW DESCRIPTIONS  
OF THE FEMALE, LARVA, AND PUPA**

MICHAEL G. POGUE AND TIMOTHY P. FRIEDLANDER

Department of Entomology, U.S. National Museum, NHB-127,  
Smithsonian Institution, Washington, D.C. 20560, and  
Department of Entomology, Texas A&M University,  
College Station, Texas 77843-2475

*Abstract.*—*Cochylis caulocatax* Razowski was previously known only from the type series, 2 males, from Venezuela. The adults, male and female genitalia, larva, and pupa are described and illustrated. Larvae feed on stamens of *Eustoma grandiflorum* (Raf.) Shinnery (Gentianales: Gentianaceae) in early instars, then burrow into ovaries feeding on developing seeds and supporting tissues. The moth is known from north central Kentucky, southeastern Texas, eastern Mississippi, south central Florida, and central Venezuela. Two generations per year occur in the Nearctic: 1) mid-June through July and 2) September to mid-October. Collections from Venezuela were in mid-February. Two parasites were reared, a braconid, *Bracon* sp., and a chalcidid, *Spilochalcis sanguiniventris* (Cresson).

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Host plant and biological information on Nearctic Cochylini are poorly known. This can be attributed to the habitus of the larvae, boring in stalks, roots, seedheads, or pods of the host. Palaearctic species of *Cochylis* are most frequently found in the flowers and seedheads of Compositae. Other hosts include species of Dipsacaceae, Scrophulariaceae, Campanulaceae, and Linaceae (Razowski, 1970). A series of the recently described *Cochylis caulocatax* Razowski was reared from *Eustoma grandiflorum* (Raf.) Shinnery (Gentianales: Gentianaceae) by the junior author in Texas. Until now this species was known only from the type series, 2 males from central and east central Venezuela (Razowski, 1984).

Adults are illustrated with descriptions of the male, female, larva, and pupa. Means and standard deviations are given for all measurements. The letter "N" denotes number of specimens examined. Color names used are followed by a parenthetical number indicating colors under the system of Smithe (1975, 1981). Larval chaetotaxy follows Hinton (1946).

*Cochylis caulocatax* Razowski  
Figs. 1-18

*Cochylis caulocatax* Razowski, 1984:278.

*Adult male* (Fig. 1). Length of forewing 3.3-4.8 mm ( $\bar{x}$  = 4.3  $\pm$  0.4 mm, N = 11).

**HEAD.** Labial palpus short, porrect, scales of middle segment expanded dorsally, ventral scales expanded almost to apex of apical segment, external scales tawny olive, internal scales cream (54); apical segment 0.7 length of basal segment; middle segment

2.1 length of basal segment, 0.9–1.0 times vertical eye diameter. Antennae filiform, 39–41 segments, scape and dorsal scaling tawny to tawny olive, setose ventrally.

**THORAX.** Mesonotum and tegula tawny olive; lateral scale tufts of metanotum and scales of scutellum cream to glaucous (80). Underside pale horn color (92); pro- and mesothoracic legs chestnut (32), tibia and tarsus suffused with varying amounts of black scales, tibia with faint apical rings; metathoracic leg pale horn color, tibial spurs and tarsus suffused with glaucous scales.

**FOREWING.** Length 2.5–2.9 times maximum width. Ground color tawny olive (223 D); elongate spot along costa from base to 0.25 wing length chestnut; distinct median band tawny (38), from costa to dorsum; faded subapical costal spot tawny; from middle of outer edge of median band a few jet black (89) scales form a broken line to basal edge of tornus; a few jet black spots along dorsum subbasally to edge of tornus; fringe tawny olive. Underside ground color blackish neutral gray (82), tawny along costa; fringe tawny olive, basal band tawny.

**HINDWING.** Length 3.8–4.2 mm ( $\bar{x} = 3.9 \pm 0.1$  mm,  $N = 9$ ); length 2.5–3.2 times maximum width. Upper side entirely white, some specimens with apex and terminal area suffused with glaucous (80); fringe white, a pale glaucous basal band present on specimens that are suffused with glaucous terminally. Underside white suffused with blackish neutral gray scales in and above discal cell to costa; area above Sc vein flushed with tawny; fringe concolorous with upperside.

**ABDOMEN.** Varying from entirely tawny olive to glaucous above and tawny below, with genital tuft tawny olive.

**MALE GENITALIA** (Figs. 3, 4). Uncus and gnathos absent. Tegumen short. Socii lobate, fused basally, attached to apex of tegumen. Transtilla a well developed band, medially produced into a curved process extending above tegumen. Valva triangulate, sacculus modified into a well sclerotized elongate spine. Vinculum arms free, with expanded lateral plates. Aedeagus ventrally deflected medially at a right angle, dorso-lateral process at right angle; cornuti absent.

*Adult female* (Fig. 2). As described for male except as follows. Forewing length 4.2–5.3 mm ( $\bar{x} = 4.8 \pm 0.3$  mm,  $N = 19$ ); length 2.6–3.0 times maximum width. Hindwing length 3.8–4.6 mm ( $\bar{x} = 3.9 \pm 0.2$  mm,  $N = 19$ ); length 2.4–3.1 times maximum width. Hindwing upperside entirely blackish neutral gray; fringe white, lightly suffused with tawny olive and glaucous (80), basal band blackish neutral gray. Underside and fringe concolorous with upperside. Abdomen blackish neutral gray above and tawny olive below.

**FEMALE GENITALIA** (Fig. 5). Papilla analis thin, lightly sclerotized. Apophysis anterior with ventral arm reduced. Sterigma a well sclerotized half circle. Colliculum well developed, hour-glass shaped. Ductus bursae short, forming a small sac, with corpus bursae originating from just below sterigma. Accessory bursa present, originating laterally from ductus bursae just below sterigma.

*Larva* (Figs. 4–10). Length of larvae 4.3–6.8 mm ( $\bar{x} = 5.4 \pm 1.1$  mm,  $N = 4$ ).

**HEAD.** Hypognathous, maximum width 1.07 mm. Color uniformly burnt sienna (132) in alcohol. Puncture AFa slightly closer to AF2 than AF1. Puncture Pb slightly caudad from P1 and P2. Puncture Pa slightly closer to L1 than P2. Puncture Ga dorsal from G1 and O3. Six stemmata present with 4 and 5 contiguous. Mandible with 5 cusps, fifth reduced. Labrum with 4 pairs of dorsal setae, 3 pairs of ventral epipharyngeal setae.



Figs. 1, 2. *Cochylis caulocatax* Razowski, adults. 1. Male, TEXAS: Walker Co., vic. Huntsville, seed pods of *Eustoma grandiflorum* (Raf.) Shinnery = bluebells, pods coll. 21–31.VIII, emerged 24–26.IX.1983, M. Moldenhauer, leg., T. Friedlander. 2. Female, same data as male except emerged 15.IX.1983.

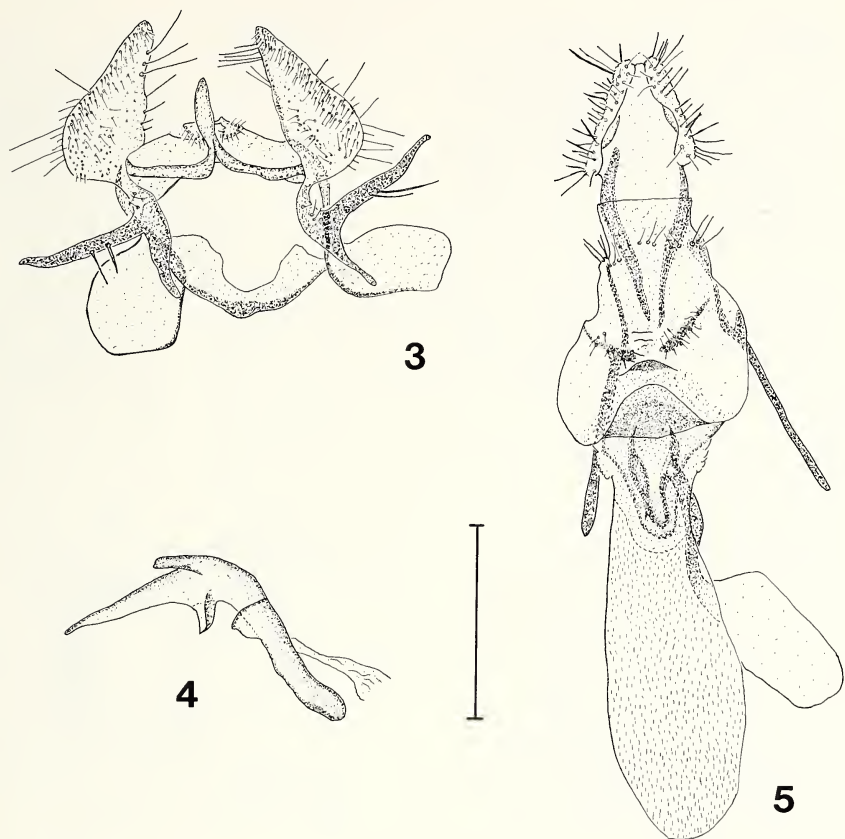
**THORAX.** Prothoracic shield unicolorous with head. Prothorax with L group on same pinaculum; mesothorax with L3 on separate pinaculum. Prothorax with SV1 and SV2 on same pinaculum; mesothorax with only SV1 present. Legs 3-segmented, single tarsal claw.

**ABDOMEN.** SD2 minute; ninth segment with D1 and SD1 on same pinaculum. Only SV2 on segment 8; SV3 absent from segment 9. Prolegs on segments 3–6 and 10; crochets on abdominal segments 3–6 uniordinal and arranged in a complete circle composed of approximately 30 spines; anal prolegs with crochets arranged in a semi-ellipse with 17 spines.

*Pupa* (Figs. 11–16). Male length 5.1–5.8 mm ( $\bar{x} = 5.4 \pm 0.4$  mm,  $N = 4$ ), maximum width 1.2–1.9 mm ( $\bar{x} = 1.5 \pm 0.4$  mm,  $N = 3$ ); female length 5.4–6.1 mm ( $\bar{x} = 5.7 \pm 0.3$  mm,  $N = 7$ ), maximum width 1.5–1.6 mm ( $\bar{x} = 1.5 \pm 0.04$  mm,  $N = 6$ ) (in alcohol). Eyes clearly visible. A row of minute posterior spines on abdominal segments 2–8 of male and 2–7 of female. A row of well developed anterior spines on segments 3–9 on both sexes. Spiracles are peg-shaped and protrude from abdominal segments 2–7. Antennal length equal to length of mesothoracic leg. Metathoracic leg protruding beyond wing tips. A single genital slit on a pad in middle of segment 9 in male. Female with 2 genital slits, one on posterior edge of segment 8, another on anterior edge of segment 9. Male cremaster with 4 hooks on anterior edge; two pair of lateral, and 2 caudal hooks on segment 10. Female cremaster with 4 hooks on anterior edge; two pair of anterolateral hooks, 2 lateral, and 2 caudal hooks on segment 10.

*Type.* Holotype male; in collection of United States National Museum of Natural History, Smithsonian Institution, Washington, D.C.

*Type locality.* VENEZUELA: Bolivar, Morichal Tauca, 22 km E Rio Caura.



Figs. 3–5. *Cochylis caulocatax* Razowski, genitalia. 3. Ventral view of male, genitalia slide MGP 677. 4. Lateral view of aedeagus. 5. Ventral view of female, genitalia slide USNM 23453 (scale = 0.5 mm).

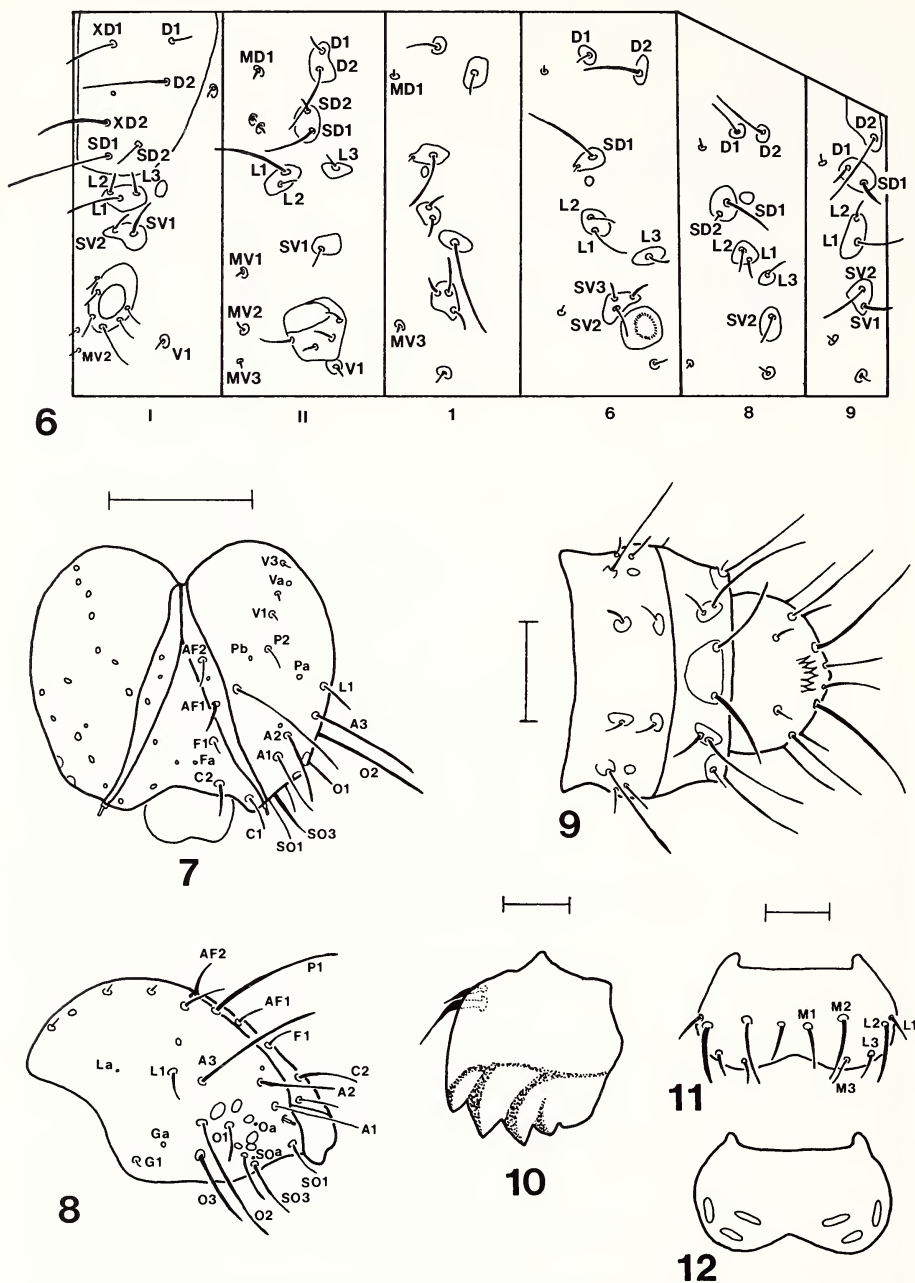
*Host.* Gentianaceae, *Eustoma grandiflorum* (Raf.) Shinnery in the Nearctic; boring in seed pods. The host is unknown in Venezuela. *Eustoma* does not occur in the Neotropics. Another genus of Gentianaceae may be the host in Venezuela.

*Flight period.* There are at least 2 generations per year, mid-June through July, and September to mid-October. In Venezuela this species has only been collected from 8 to 13 February.

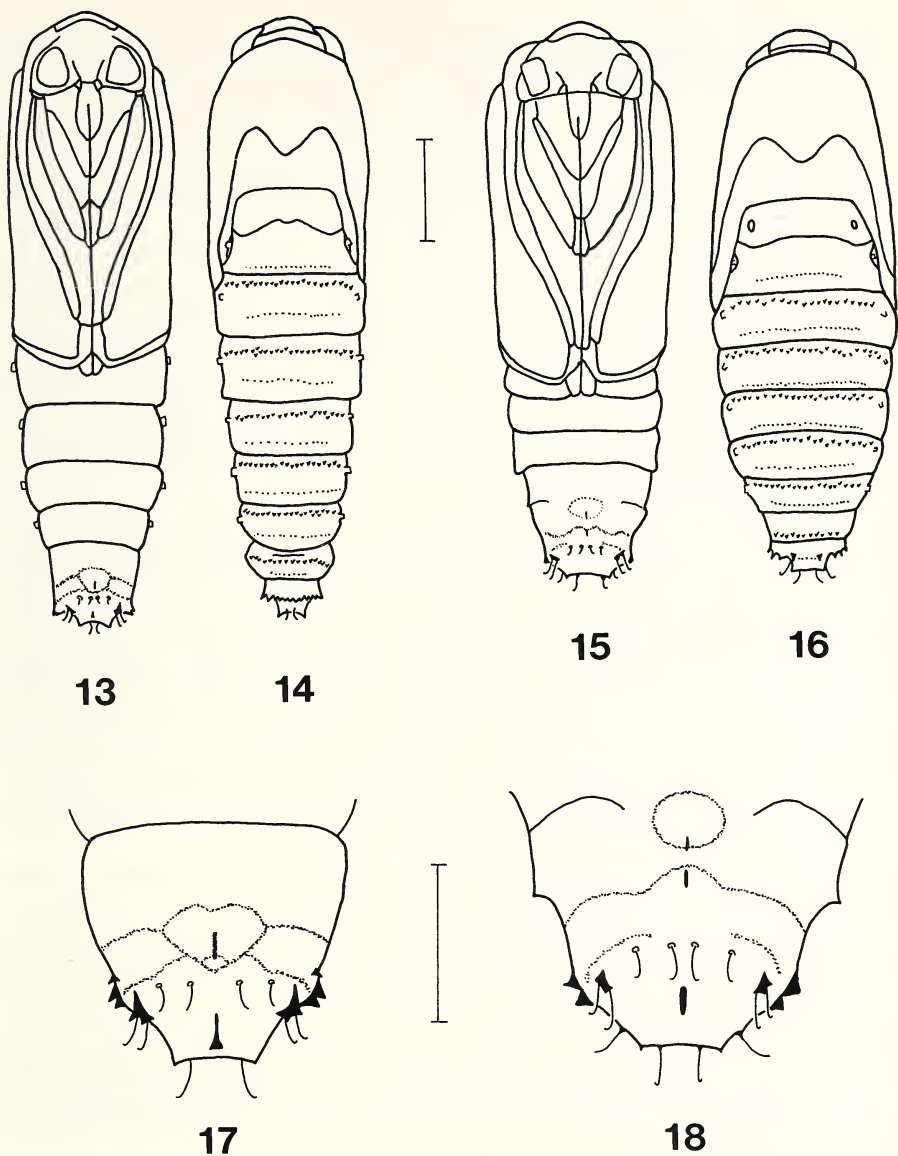
*Distribution.* North central Kentucky, southeastern Texas, eastern Mississippi, south central Florida, and central to east central Venezuela.

*Material examined.* 17 males, 28 females, 4 larvae, and 16 pupae. VENEZUELA: Bolivar: Morichal Tauca, 22 km E Rio Caura, 1 male (holotype), 8–9 Feb. 1976. Parque Llovizna, Rio Caroni, Cd. Guayana, 1 male (paratype), 13 Feb. 1976. UNITED STATES: FLORIDA: Highlands Co., Archbold Biological Station, 1 female, 9 July 1979. KENTUCKY: Hardin Co., Glendale, 1 male, 22 Aug.–3 Sept. 1975, malaise





Figs. 6-12. *Cochylis caulocatax* Razowski, larval chaetotaxy. 6. Lateral view of prothorax, mesothorax, and abdominal segments 1, 6, 8, and 9. 7. Dorsal view of head (scale = 0.5 mm). 8. Lateral view of head. 9. Dorsal view of abdominal segments 8-10. 10. Left mandible (scale = 0.1 mm). 11. Dorsal view of labrum (scale = 0.1 mm). 12. Ventral view of labrum.



Figs. 13–18. *Cochylis caulocatax* Razowski, pupae. 13. Ventral view of male. 14. Dorsal view of male. 15. Ventral view of female. 16. Dorsal view of female (scale = 1.0 mm). 17. Ventral view of male ultimate segment. 18. Ventral view of female ultimate segment (scale = 0.5 mm).

trap. MISSISSIPPI: Oktibbeha Co., 6 mi SW Starkville, 1 male, 21 Sept. 1984, 1 female, 11 June 1984. TEXAS: Cameron Co., S. Padre Island, 1 male, 1 Mar. 1978. Jackson Co., Deutschburg, 1 male, 8 Aug. 1973. Nueces Co., N. Padre Island, 1 male, 1 female, 21 June 1977; Padre Island National Seashore, 1 female, 19 May 1976, 1 female, 19 July 1976. San Patricio Co., Welder Wildlife Ref., 8 mi NE of Sinton, 1 male, 1 female, 29–30 July 1975. Walker Co., Huntsville, 1 male, 2 females, June 1983, *Eustoma grandiflorum*. vic. Huntsville, 9 males, 20 females, pods coll. 21–31 Aug. 1983, seed pods *Eustoma grandiflorum* (Raf.) Shinnery = bluebells, emerged 8 Sept.–6 Oct. 1983.

*Parasites.* Two species were reared from *Cochylis caulocatax*, a braconid *Bracon* sp. and a chalcidid *Spilochalcis sanguiniventris* (Cresson). *S. sanguiniventris* is principally a primary parasite of Lepidoptera having been reared from 10 different families. It has also been reared from several species of Curculionidae (Coleoptera). It is also a secondary parasite on Braconidae and Ichneumonidae (Hymenoptera). *C. caulocatax* is a new host record for *S. sanguiniventris* (Krombein et al., 1979).

*Biology.* *Cochylis caulocatax* was reared from seed pods of *Eustoma grandiflorum* supplied by Marlene Moldenhauer.

Host plants bloom as early as mid-June, and some adults were observed in the spring. Eggs are probably deposited in flowers, perhaps also in developing flower buds. Larvae eat stamens (but not pistil) of the flower before burrowing into the ovary. With only 2 sizes of head capsules present in the seed pods, larvae apparently do not enter the ovary until the later instars. Larvae feed on developing seeds and tissues that supply nourishment to seeds more than in pod walls. Many damaged seed pods still produced some normal seeds. The last instar larva chews a hole, generally in the base, but occasionally in the top of one of 2 halves of the pod, leaving a thin skin of plant tissue through which the pupa emerges. A pupation chamber inside the pod is connected by a silk-lined tunnel to the exit hole. On emergence, the adult leaves the pupal skin protruding half way out of the exit hole. Adults emerge in early morning and are ready to fly at dusk.

Of 188 pods collected, 50 showed evidence of larval damage. At least 10% of the latter harbored more than one larva.

*Discussion.* The tawny olive ground color of the forewing of *Cochylis caulocatax* is shared with several undescribed species of Nearctic *Cochylis*. However, the well developed tawny median band and subapical costal spot are good characters to distinguish *C. caulocatax*.

Sexual dimorphism occurs in the hindwing color of about half the *Cochylis* species, with the female wing darker. The male genitalia possess 2 characters that identify *C. caulocatax*: 1) sacculus is modified into an elongate spine and 2) a dorsolateral process of aedeagus.

#### ACKNOWLEDGMENTS

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stitution, and John E. Rawlins, Carnegie Museum of Natural History for critically reviewing the manuscript and giving us many helpful suggestions. We also thank Paul M. Marsh and E. E. Grissell, Systematic Entomology Laboratory, IIBIII, for parasite determinations.

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## SIX NEW SPECIES OF *TENTHREDO* LINNAEUS (HYMENOPTERA: TENTHREDINIDAE) FROM INDIA

DEVINDER SINGH AND MALKIAT S. SAINI

Department of Zoology, Punjabi University, Patiala-147002, India

**Abstract.**—Six new species of *Tenthredo* are described from India: *garhwali*, *manganensis*, *flatopleura*, *muche*, *corrugatocephala* and *valvurata*. The genitalia are illustrated and the new species are separated from previously described related taxa. The population variation is also discussed.

Malaise's (1945) comprehensive study on southeastern Asian *Tenthredo* brought together all of the previously scattered work on this genus and is still the most exhaustive study available. He added 18 new species to the Indian fauna. The only additional works since Malaise are that by Muehe (1982, 1983) who described an additional three species from India. In this paper, one of a series of papers on Indian *Tenthredo*, six new species are described. The terminology follows that of Ross (1937, 1945) and Malaise (1945). Holotypes and paratypes are deposited in the IARI, PUSA National Collection, New Delhi, India.

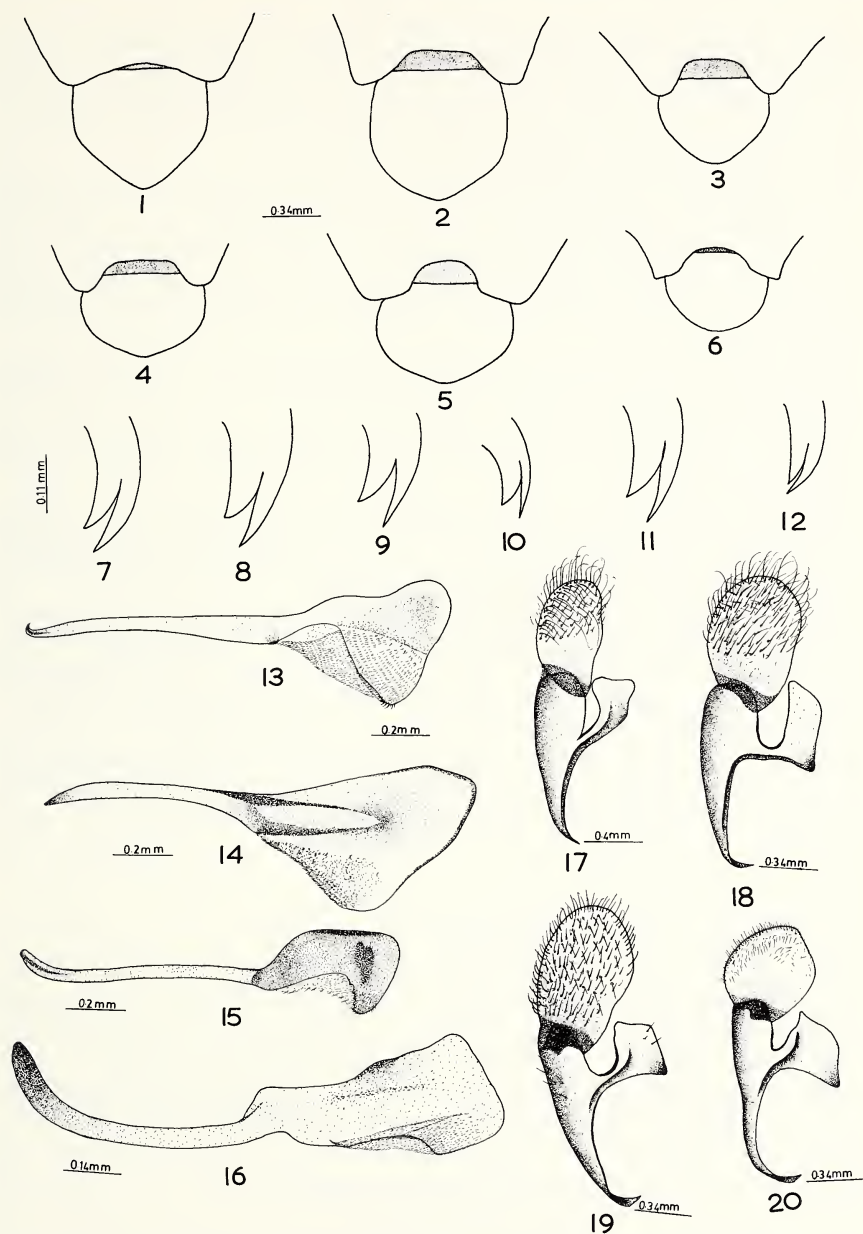
The following abbreviations are used in the descriptions: EL—eye length; ICD—intercenchii distance; IDMO—interocular distance at level of median ocellus; ITD—intertegular distance; LID—lower interocular distance; OCL—oculo-occipital line; OOL—oculo-ocellar line; POL—post-ocellar line.

### ***Tenthredo garhwali*, new species**

Figs. 1, 7, 13, 17, 21

**Description.** FEMALE. Average length, 12.2 mm. Body black, pale green as follows: basal half of mandible; face below antenna; lower half of hind orbit; tip of supraantennal tubercle; dorsal and ventral angles of pronotum; tegula; triangular apex of mesonotal middle lobe; meso- and metascutelli and spots lateral to them; ridges lateral to meso- and metascutelli; medial band along anterior margin of metapostnotum; spot on posterodorsal aspect of meso- and metepimera; mesepisternum except anterodorsal angle; metepisternum; triangular medial spot on propodeum; medial longitudinal band of equal width on terga 2-5, decreasing in width on 6-9; underside of abdomen; pro- and mesolegs except posterior stripe along distal halves of femora, tibiae and mesobasitarsus (tips of tarsal joints infusate); metacoxa except outer stripe; underside of metatrochanter and femur. Wings dusky hyaline, stigma and venation dark brown to black.

Antenna slightly compressed,  $2.3 \times$  head width, segments 3 and 4 in ratio 4:3; clypeus (Fig. 1) slightly, roundly emarginate; labrum indistinctly broader than long with subacuminate anterior margin; malar space  $0.5 \times$  diameter of lateral ocellus; LID:IDMO:EL = 2.0:4.4:4.3; OOL:POL:OCL = 3.8:1.0:1.9; frontal area much below level of eyes; supraantennal tubercle slightly raised and merging into insignificant frontal ridge; median fovea shallow with flat bottom; circumocellar furrow absent,



Figs. 1-20. 1-6. Clypeus. 1. *garhwali*. 2. *manganensis*. 3. *flatopleura*. 4. *muchi*. 5. *corrugatocephala*. 6. *valvurata*. 7-12. Tarsal claw. 7. *garhwali*. 8. *manganensis*. 9. *flatopleura*. 10. *muchi*. 11. *corrugatocephala*. 12. *valvurata*. 13-16. Penis valve. 13. *garhwali*. 14. *manganensis*. 15. *corrugatocephala*. 16. *valvurata*. 17-20. Gonoforceps. 17. *garhwali*. 18. *manganensis*. 19. *corrugatocephala*. 20. *valvurata*.

inter- and postocellar ones clear; lateral furrow deep; postocellar area subconvex, broader than long in ratio 2:1; head narrowing behind eyes; ITD:ICD = 2.9:1.0; mesoscutellum roundly raised with faint transverse carina; appendage not carinate; mesepisternum obtusely raised to rounded apex; mesosternum lacking thorns; apical tooth of claw (Fig. 7) longer than subapical; metabasitarsus as long as following 3 joints combined; metafemur slightly shorter than tibia.

Head shining with few indistinct punctures, hind orbit minutely and densely punctured; mesonotum also shining with minute and distinct punctures, particularly along seams; mesoscutellum distinctly punctured on posterior slope only; appendage, metanotum and scutellum impunctate; mesepisternum shallowly punctured with sebaceous lustre; mesosternum densely punctured; abdomen uniformly, densely and minutely punctured.

Lancet (Fig. 21) with 25 serrulae, each serrula almost flat having single indistinct anterior and several small posterior subbasal teeth.

MALE. Average length, 11.0 mm. Similar to female except: mesosternum entirely pale; terga 7–9 almost entirely black; mesotarsus black. Penis valve (Fig. 13) and gonoforceps (Fig. 17).

*Material examined.* HOLOTYPE: Female, Uttar Pradesh, Mandal, 2,080 m, 23.6.1983. PARATYPES: 11♀♀, 8♂♂ with same data as holotype. 1♀, Uttar Pradesh, Hanumanchatti, 2,400 m, 1.6.1984. 1♂, Himachal Pradesh, Kalatop, 2,385 m, 1.7.1984. 2♀♀, Sikkim, Mangan, 1,280 m, 13.5.1985.

*Remarks.* This new species shows close similarity to *T. simlaensis* Cameron, 1876. However, it can be distinguished from the latter on account of having inner orbit not green, postocellar area entirely black, antenna totally black, temple without a pale spot, antenna filiform and mesepisternum shallowly punctured.

In *T. simlaensis* the inner orbit and lateral side of the postocellar area are pale green, the scape is pale green in male, the temple has pale spot, the antenna is distinctly incrassate and apex of mesepisternum has distinct and deep punctures.

*Etymology.* The species is named after the hills among which is situated its type locality.

### ***Tenthredo manganensis*, new species**

Figs. 2, 8, 14, 18, 22

*Description.* FEMALE. Average length, 11.6 mm. Head and thorax yellowish, black as follows: flagellum of antenna; mandible tip; frontal spot anteriorly covering median and lateral foveae leaving supraantennal tubercle, laterally not touching eye margin and posteriorly reaching hypothetical hind margin of head; postocellar area; median and lateral spots on posterior side of head; irregular medial transverse stripe on pronotum; mesonotum except V-shaped margin of middle lobe and broad spot outer to scutellum on lateral lobe; band along hind margins of meso- and metascutelli; nebulous spot on mesopostnotum; metanotum except spot lateral to scutellum; narrow hind margin of metapostnotum; parapterum; stripe along each pleural suture; mesosternum except stripe along medial groove. Abdomen yellowish brown except black lateral spots (confluent in middle) on terga 1–4, and following pale: posterior margin and lateral side of propodeum; deflexed sides of terga 6–9; small nebulous spot on each sternum. Legs yellowish with the following reddish brown: mesofemur

posteriorly in distal half; metafemur except immediate base; meso- and metatibiae and tarsi. All tarsal joints infusate towards tips. Wings yellowish hyaline, forewing subinfumate towards apex, costa and stigma reddish yellow, venation dark brown.

Antenna slightly compressed towards apex,  $2.2\times$  head width, segments 3 and 4 in ratio 4:3; clypeus (Fig. 2) roundly to subsquarely incised up to  $\frac{1}{5}$  of its medial length; labrum broader than long in ratio 6:5 with narrowly rounded anterior margin; malar space  $0.6\times$  diameter of lateral ocellus; LID:IDMO:EL = 2.0:4.0:4.1; OOL:POL:OCL = 3.5:1.0:2.2; frontal area below level of eyes; supraantennal tubercle raised and merging into insignificant frontal ridge; median fovea narrow, faintly carinate; circum-, inter- and postocellar furrows clear; lateral furrow sunken and slightly diverging posteriorly; postocellar area subconvex, broader than long in ratio 3:2 at maximum width; head narrowing behind eyes; ITD:ICD = 2.7:1.0; meso-scutellum roundly raised; appendage faintly carinate; mesepisternum obtusely raised with short, blunt carina at apex; mesosternum cornered but without distinct thorns; apical tooth of claw (Fig. 8) longer than subapical; metabasitarsus as long as following 3 joints combined; metafemur shorter than tibia.

Head shining, almost impunctate; mesonotum polished having few punctures on middle lobe; mesoscutellum with deep and distinct punctures on posterior slope only; appendage, metanotum and scutellum impunctate; mesepisternum shallowly punctured with sebaceous lustre; mesosternum minutely and distinctly punctured; propodeum shining, remaining terga faintly microsculptured.

Lancet (Fig. 22) with 28 serrulae, each serrula quite flat having 2 anterior and up to 25 small posterior subbasal teeth.

MALE. Average length, 10.7 mm. Similar to female except: mesosternum pale leaving narrow anterior margin; metacoxa with black outer stripe. Penis valve (Fig. 14) and gonoforceps (Fig. 18).

*Material examined.* HOLOTYPE: Female, Sikkim, Mangan, 1,200 m, 13.5.1985. PARATYPES: 4♂, with same data as holotype. 2♀, Uttar Pradesh, Mandal, 2,150 m, 15-16.6.1985.

*Variation.* Most of mesopleuron black.

*Remarks.* In Malaise's (1945) key this species shows distant similarity to *T. siabataka* (Rohwer, 1921). However, it can be separated from the latter by the yellowish ground color of the head, the metafemur and tibia without black, the abdomen without red, the stigma yellowish brown and the head narrowing behind eyes.

In *T. siabataka* the ground color of the head is black, the metafemur and tip of the tibia are black, the abdominal segments 2-5 are reddish, the stigma is black and the head is dilated behind eyes.

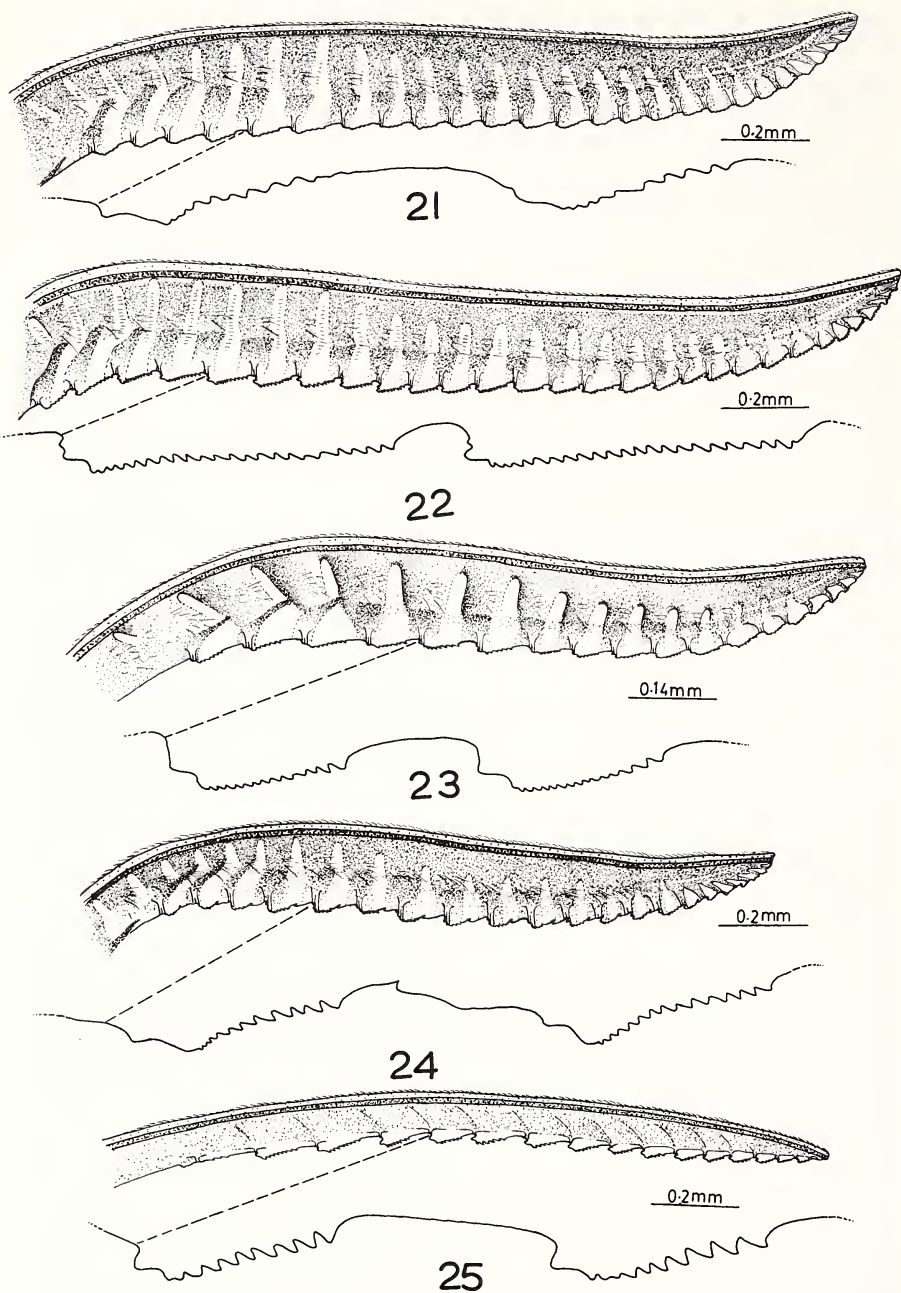
*Etymology.* The species name has been taken from the type locality.

### ***Tenthredo flatopleura*, new species**

Figs. 3, 9, 23

*Description.* FEMALE. Length, 9.8 mm. Body black, reddish brown as follows: mandible except extreme apex; femora except immediate bases; meso- and metatibiae and tarsi except some infuscation on posterior side. Wings clear, costa and stigma brown, venation dark brown to black.





Figs. 21–25. Lancet. 21. *garhwali*. 22. *manganensis*. 23. *flatopleura*. 24. *muchi*. 25. *corrugatocephala*.

Antenna filiform,  $2.8 \times$  head width, segments 3 and 4 in ratio 6:5; clypeus (Fig. 3) subsquarely incised up to  $\frac{1}{3}$  of its medial length; labrum cordate, broader than long in ratio 6:5 with roundly pointed anterior margin; malar space  $2.2 \times$  diameter of lateral ocellus: LID:IDMO:EL = 2.0:2.5:2.3; OOL:POL:OCL = 3.3:1.0:1.7; frontal area almost at level of eyes; supraantennal tubercle moderately raised and confluent with similar frontal ridge; median fovea ditch-like with shallow pit in front of median ocellus; circum- and postocellar furrows sharp, interocellar one pit-like; lateral furrow sunken, slightly diverging posteriorly; postocellar area flat, sloping backwards and broader than long in ratio 7:4; head narrowing behind eyes; ITD:ICD = 3.3:1.0; mesoscutellum subpyramidally raised with distinct longitudinal carina; appendage carinate; mesepisternum almost flat and both sides of thorax appear parallel when seen from front, anteriorly and below with curved carina; mesosternum lacking thorns; apical tooth of claw (Fig. 9) longer than subapical; metabasitarsus much longer than following 3, but shorter than remaining 4 joints combined; metafemur shorter than tibia.

Frontal area with large, shallow and almost confluent punctures, rest of head minutely and densely punctured; mesonotum dull, densely punctured; mesoscutellum and appendage densely punctured along with microsculpture; metanotum and scutellum with shallow punctures and microsculpture; mesepisternum rugose posterior to carina; anterior aspect of mesepisternum and sternum entirely, densely and distinctly punctured; abdomen microstriated.

Lancet (Fig. 23) with 18 serrulae, each serrula with single shelf-like anterior and numerous posterior subbasal teeth.

MALE. Unknown.

*Material examined.* HOLOTYPE: Female, Uttar Pradesh, Mandal, 2,100 m, 25.6.1985.

*Remarks.* This new species is quite closely related to *T. cyanata* Konow, 1898. However, it can be easily distinguished from the latter by the black labrum, clypeus and dorsal angle of pronotum, predominant reddish brown color on legs, antennal segment 3 longer than 4, and the subpyramidally raised mesoscutellum.

In *T. cyanata* the labrum, clypeus and dorsal angle of pronotum are pale, the legs are black with pale markings, antennal segment 3 is shorter than 4 and the mesoscutellum is only slightly raised.

*Etymology.* The species name pertains to the almost flat mesopleuron.

### ***Tenthredo muchei*, new species**

Figs. 4, 10, 24

*Description.* FEMALE. Length, 11.4 mm. Antenna black except distal  $\frac{1}{3}$  of segment 6, and 7–9 entirely, brownish yellow. Head pale, black as follows: mandible tip; broad frontal spot anteriorly covering median fovea leaving tip of supraantennal tubercle, laterally not touching eyes and posteriorly reaching hypothetical hind margin of head; postocellar area; broad medial spot on hind orbit; posterior side of head except spot behind postocellar area. Thorax and abdomen black, pale yellow are: broad dorsal and ventral angles of pronotum; tegula; triangular apex of mesonotal middle lobe; meso- and metascutelli; appendage; medial spot on metapostnotum; small spot on mesepimeron; large spot on mesepisternum; metepisternum; stripe along posterior

margins of terga 2-5 and 8 (this stripe triangularly broadened in middle, becoming narrow towards lateral side and again broadened on deflexed aspect); medial triangular spot near distal margins of terga 6 and 7; tip of abdomen; all sterna; trochanters along with adjacent parts of coxae and femora; frontside of procoxa, femur and tibia; middle of tibiae; infuscated tips of all tarsal joints. Wings clear, apex of fore one subinfusate, costa and stigma fulvous, venation light to dark brown.

Antenna filiform,  $2.6 \times$  head width, segments 3 and 4 in ratio 4:3; clypeus (Fig. 4) roundly to squarely incised up to  $\frac{2}{3}$  of its medial length; labrum broader than long in ratio 3:2 with deflexed and rounded anterior margin; malar space  $2.1 \times$  diameter of lateral ocellus; LID:IDMO:EL = 2.0:2.6:1.9; OOL:POL:OCL = 3.4:1.0:2.0; frontal area at level of eyes; supraantennal tubercle raised and confluent with similar frontal ridge; median fovea broad with deep pit in middle; circum-, inter- and postocellar furrows fine and clear; lateral furrow narrow, slightly diverging posteriorly; postocellar area convex, broader than long in ratio 3:2 at maximum width; head slightly narrowing behind eyes; ITD:ICD = 4.0:1.0; mesoscutellum distinctly raised, its posterior slope faintly carinate; appendage slightly carinate; mesepisternum obtusely raised without carina or acute apex; mesosternum angled but lacking thorns; apical tooth of claw (Fig. 10) longer than subapical; metabasitarsus as long as following 3 joints combined; metafemur shorter than tibia.

Head densely punctured with faint microsculpture, punctures become less dense and minute along hind orbit; mesonotum more regularly and densely punctured than head with strong microsculpture; mesoscutellum shallowly punctured; appendage minutely wrinkled; metanotum and scutellum with few shallow punctures; mesepisternum minutely and densely punctured, subrugose at apex; mesosternum punctulate with distinct microsculpture; abdomen faintly microstriated.

Lancet (Fig. 24) with 20 serrulae, each serrula with single shelf-like anterior and numerous posterior subbasal teeth.

MALE. Unknown.

*Material examined.* HOLOTYPE: Female, Uttar Pradesh, Flower Valley, 3,300 m, 17.6.1983.

*Remarks.* This new species shows some relationship to *T. habenata* Konow, 1907 and *T. variicolor* Malaise, 1945. However, it can be distinguished from both of them by the body without liver brown color, distal  $\frac{1}{3}$  of antennal segments 6 and 7-9 entirely yellowish, lower half of the hind orbit pale, the mesepisternum with a prominent pale spot, a single pale spot on metapleuron, black color predominant on legs, the postocellar area broader than long, the apex of mesepisternum rounded without carina and each serrula of lancet with single anterior subbasal tooth.

In *T. habenata* the hind orbit is without pale, the mesepisternum is entirely black, the metapleuron has 2 pale spots, only the stripe on the metacoxa and tips of femora and tibiae black and the postocellar area longer than broad.

In *T. variicolor* the body is liver brown with black and pale yellow markings, the apical  $\frac{1}{2}$  of antennal segments 4 and 5-8 are entirely yellowish, the mesepisternum has short carina at the apex and each serrula of lancet has 2 anterior subbasal teeth.

*Etymology.* This species has been named in honor of Dr. H. Mucho of East Germany, the only worker who has made a contribution on Indian *Tenthredo* after Malaise (1945).



***Tenthredo corrugatocephala*, new species**

Figs. 5, 11, 15, 19, 25

*Description.* FEMALE. Average length, 10.8 mm. Body black, pale to prasinus as follows: basal half of mandible; labrum and clypeus; triangular spot on supraclypeal area; dot on extreme tip of supraantennal tubercle; spot on lower hind orbit touching eye; dorsal angle of pronotum; tegula except distal spot; anterior slope of mesoscutellum; ridges lateral to meso- and metascutelli; small lateral spot on appendage; medial spot on metapostnotum; narrow hind margins of terga 2–4; deflexed sides of all terga; sterna; frontside of procoxa except small spot, pro- and mesofemora except extreme bases, pro- and mesotibiae and tarsi; narrow stripe on metafemur and tibia. Forewing yellowish hyaline, hind one clear, stigma and venation dark brown to black.

Antenna stout,  $1.8 \times$  head width, segments 3 and 4 in ratio 3:2; clypeus (Fig. 5) roundly incised up to  $\frac{2}{3}$  of its medial length with truncate lateral teeth; labrum cordate, broader than long in ratio 4:3 with roundly pointed anterior margin; malar space  $0.5 \times$  diameter of lateral ocellus; LID:IDMO:EL = 2.0:4.3:3.2; OOL:POL:OCL = 3.7:1.0:2.0; frontal area slightly below level of eyes; supraantennal tubercle raised and more or less confluent with frontal ridge; median fovea broad with shallow pit in middle and faint longitudinal carina in anterior half; circum-, inter- and postocellar furrows sharp; lateral furrow deep and slightly excurved; postocellar area subconvex, broader than long in ratio 7:4 at maximum width; head neither dilated nor narrowing behind eyes; ITD:ICD = 2.7:1.0; mesoscutellum raised with faint indication of longitudinal carina on posterior slope; appendage carinate; mesepisternum raised to acute apex; mesosternum without thorns; apical tooth of claw (Fig. 11) longer than subapical; metabasitarsus shorter than following 3 joints combined; metafemur slightly shorter than tibia.

Head strongly wrinkled with faint microsculpture, hind orbit minutely and densely punctured; mesonotum distinctly and densely punctured; anterior slope of mesoscutellum shallowly punctured, its posterior slope and appendage with large and deep punctures; metanotum distinctly punctured; metascutellum with well separated shallow punctures; mesepisternum subrugose; mesosternum distinctly punctulate; abdomen microstriated with few distinct and scattered punctures.

Lancet (Fig. 25) narrow with 17 serrulae, each serrula with single lobe-like anterior and about 10 distinct posterior subbasal teeth.

MALE. Average length, 9.2 mm. Similar to female except: metascutellum with pale spot; pale hind margins of terga 2–4 triangularly broadened in middle; head slightly narrowing behind eyes. Penis valve (Fig. 15) and gonoforceps (Fig. 19).

*Material examined.* HOLOTYPE: Female, Uttar Pradesh, Gobinddham, 3,000 m, 20.6.1985. PARATYPES: 2♀♀, 4♂♂, with same data as holotype. 1♂, Uttar Pradesh, Flower Valley, 3,300 m, 21.6.1985. 2♀♀, 4♂♂, Uttar Pradesh, Chopta, 3,000 m, 25–27.6.1985.

*Variation.* Metaleg without pale green markings; mesoscutellum entirely black.

*Remarks.* This new species shows similarity to *T. segregata* Konow, 1908a, and *T. pseudomelaena* Malaise, 1945. However, it can be distinguished from both of them by the entirely black, mesonotum, the mesoscutellum except its anterior slope, the appendage and the mesopleuron; terga 2–5 without a medial longitudinal band; the



head not narrowing behind the eyes (at least in the female) and the face strongly wrinkled on and around the frontal area.

In *T. segregata*, the medial spot on the mesonotum, the mesoscutellum and the appendage are pale; terga 2–5 possess pale longitudinal band and the face is smooth and shining.

In *T. pseudomelaena*, the mesopleuron is pale with a dorsoventral black band, the head is strongly narrowing behind eyes and the face has few scattered punctures only.

*Etymology.* The species name pertains to the strongly wrinkled head.

### ***Tenthredo valvurata*, new species**

Figs. 6, 12, 16, 20

*Description.* FEMALE. Unknown.

MALE. Length, 10.2 mm. Antenna black except; scape leaving spot on innerside, tips of segments 3 and 4 and underside of 5–9, pale. Body prasinus, black as follows: mandible tip; narrow stripe encircling each ocellus; longitudinal irregular stripe outer to frontal ridge, anteriorly reaching supraantennal pit and expanded laterally at level of lateral ocellus; spot near posterolateral corner of postocellar area; stripe along anterior  $\frac{2}{3}$  of median furrow of mesonotal middle lobe and Y-shaped mark near its apex extending up to mesoscutellum; two irregular spots on mesonotal lateral lobe; spot lateral to cenchrus and one on deflexed area of metanotum; narrow hind margin of metapostnotum; narrow stripe interrupted in middle along basal margins of terga 2–4; stripe along apical half of metacoxa and trochanter, distal half of profemur, meso- and metafemora, and all tibiae, posteriorly; inner and outer stripes on metatarsus. Wings clear, costa and stigma pale green, venation dark brown to black.

Antenna filiform,  $2.6 \times$  head width, segments 3 and 4 in ratio 5:4; clypeus (Fig. 6) broadly subsquarely incised up to  $\frac{1}{2}$  of its medial length with triangular lateral teeth; labrum broader than long in ratio 7:6 with rounded anterior margin; malar space  $9.5 \times$  diameter of lateral ocellus; LID:IDMO:EL = 2.0:3.8:4.0; OOL:POL:OCL = 3.3:1.0:2.2; frontal area much below level of eyes; supraantennal tubercle distinctly raised, sloping back and more or less confluent with frontal ridge; median fovea broad and shallow; circum-, inter- and postocellar furrows sharp; lateral furrow deep; postocellar area subconvex, broader than long in ratio 7:4; head strongly narrowing behind eyes; ITD:ICD = 2.7:1.0; mesoscutellum distinctly raised, bluntly pointed and with transverse carina; appendage faintly carinate; mesepisternum obtusely raised with rounded apex; mesosternum lacking thorns; apical tooth of claw (Fig. 12) longer than subapical; metabasitarsus shorter than following 3 joints combined; metafemur as long as tibia.

Head subshining, minutely, sparsely and shallowly punctured; mesonotum polished; mesoscutellum with some fine punctures; appendage impunctate; metanotum and scutellum with few shallow punctures; mesepisternum smooth with sebaceous luster; mesosternum punctulate; abdomen faintly microsculptured. Penis valve (Fig. 16) and gonoforceps (Fig. 20).

*Material examined.* HOLOTYPE: Male, Himachal Pradesh, Narkanda, 2,080 m, 25.5.1984.

*Remarks.* This new species shows similarity to *T. trunca* Konow 1908b and *T.*

*chlorogaster* Malaise, 1945. However, it is distinguished from both of these species due to having tips of antennal segments 3 and 4 along with the underside of 5–9 pale, median fovea without black, clypeus deeply and distinctly incised, mandible normal and mesonotum polished with strong luster.

In *T. trunca*, the flagellum is entirely black, the anterior margin of clypeus is almost truncate and the mandible has a strong mesial flap.

In *T. chlorogaster*, the median fovea is black and the mesonotum is opaque due to strong microsculpture.

*Etymology.* The species name pertains to the characteristic shape of the valvura in penis valve.

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## NOTES AND COMMENTS

### CHROMOSOME STUDY OF TWO NEOTROPICAL SPECIES OF GERRIDAE (HEMIPTERA: HETEROPTERA)

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We report the chromosome numbers and sex determination mechanisms for males of two Neotropical genera of Gerridae (Hemiptera: Heteroptera), *Brachymetra* Mayr and *Tachygerris* Drake; this represents the first study of chromosomes in Neotropical gerrids. We also comment on the congruence between cytogenetic and morphological characters in the family.

*Brachymetra* and *Tachygerris* overlap in geographical distribution and they frequently co-occur in the same pools and streams (Calabrese, 1980). Two existing phylogenetic reconstructions for the Gerridae (Calabrese, 1980; Andersen, 1982), which are based on different sets of morphological characters, reveal the same clade placement for the two genera: *Brachymetra* is the sister-group of *Charmatometra* Kirkaldy and *Tachygerris* is in the same clade as *Gerris* Fabricius, a cosmopolitan genus. More synapomorphies define the clade which includes *Tachygerris* than define the clade which includes *Brachymetra*; neither genus belongs to a highly derived clade (Calabrese, 1985).

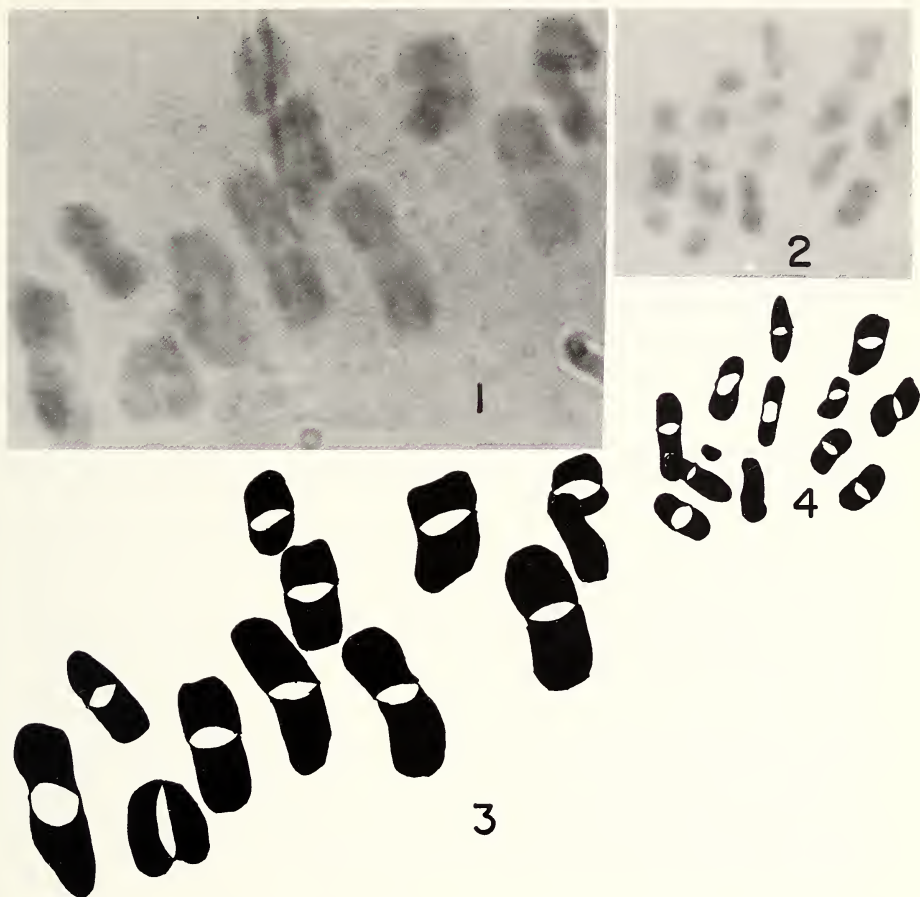
Specimens of *Brachymetra albinerva* Amyot and Serville and *Tachygerris opacus* (Champion) were collected on Barro Colorado Island, Republic of Panama, in March 1984. All adult males were fixed in the field in a 9:3:1 solution of absolute ethanol: glacial acetic acid:acetone (O'Rourke's fixative). Within a few months testes were dissected out, stained for approximately five minutes in a preparation of lacto-proprio-orcin, and squashed. Temporary slides were scanned under oil immersion for meiotic figures. Figures were photographed at 1,500 $\times$  with a Bausch and Lomb Balplan phase-contrast microscope with a C-35 camera attachment. Figures were subsequently enlarged when prints were made.

Chromosome numbers and sex determination mechanisms can be summarized as follows (N, male): *Tachygerris opacus* (Figs. 1, 3) 11 + XO; *Brachymetra albinerva* (Figs. 2, 4) 11 + XY.

Kinetochores are restricted to the terminal ends of meiotic chromosomes in both taxa and m chromosomes are absent (Figs. 3, 4).

Chromosome sizes (lengths) range from 1.0 to 1.5  $\mu$ m (Figs. 1, 2).

We have suggested elsewhere that the XY sex determination mechanism is ancestral within the Gerridae and that more derived groups exhibit higher chromosome number (Calabrese and Tallerico, 1984). We do not suggest there is consistency of chromosome number and sex determination mechanism within each genus. We do suggest, however, that when the results of the study of *B. albinerva* and *T. opacus* are considered within the context of existing phylogenetic reconstructions (Calabrese, 1980; Andersen, 1982), they corroborate our hypotheses: The less derived group, *Brachymetra*, retains an XY mechanism, heterogametic type, of sex determination;



Figs. 1–4. 1. Metaphase I. *Tachygerris opacus*; 1 cm = 1  $\mu$ m. 2. Metaphase I. *Brachymetra albinerva*; 1 cm = 0.5  $\mu$ m. 3. 'Bubble' diagram for Figure 1 to illustrate terminal kinetochores; 1 cm = 1  $\mu$ m. 4. 'Bubble' diagram for Figure 2 to illustrate terminal kinetochores; 1 cm = 0.5  $\mu$ m.

the more derived group, *Tachygerris*, exhibits an XO mechanism, heterogametic type, of sex determination. Neither group exhibits a total chromosome number which would be characteristic of a highly derived gerrid group. For example, species of the highly derived genus *Halobates* Escholtz exhibit diploid numbers of  $30 + XO$  in the males (Newman and Cheng, 1983).—Diane M. Calabrese, Department of Biology, Dickinson College, Carlisle, Pennsylvania 17013, and Peter Tallerico, Harrisburg Hospital, Harrisburg, Pennsylvania 17011.

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REVISION OF NORTH AMERICAN SPECIES OF  
*ILYBIUS* ERICHSON (COLEOPTERA: DYTISCIDAE),  
WITH SYSTEMATIC NOTES  
ON PALAEARCTIC SPECIES

D. J. LARSON

Department of Biology, Memorial University of Newfoundland,  
St. John's, Newfoundland A1B 3X9, Canada

**Abstract.**—Adults of the North American species of the holarctic genus, *Ilybius* Erichson, are reviewed, and keys for their recognition, descriptions, and maps of distributions are presented. Fourteen species are recognized. The following new synonymies are proposed: *Ilybius laramaeus* LeConte is a junior synonym of *I. biguttulus* Germar; *I. denikei* Wallis is a junior synonym of *I. confusus* Aubé; and *I. suffusus* Crotch is a junior synonym of *I. subaeneus* Erichson. The genus is primarily northern, with the majority of species in the northern Appalachian and boreal regions. Four species are holarctic.

The distribution of character states among species is discussed and a cladogram is presented for North American species. Two subgenera are recognized: *Agabidius* Seidlitz with two species in Asia; and *Ilybius* s. str. to which all North American species are assigned. Although not included in the cladogram, the distribution of character states among Palearctic species is discussed and the positions of these species in the cladogram are noted.

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SYSTEMATIC POSITION OF *ILYBIUS* ERICHSON

The genus *Ilybius* is one of the more sharply defined genera within the dytiscid subfamily Colymbetinae. Characteristics of the genus are given by Leech (1942) and Leech and Chandler (1956) in the key to North American genera of Dytiscidae, and a description of the genus is given by Larson (1975).

Although *Ilybius* is well defined, its systematic position has been debated. Most authors follow Sharp (1882) in assigning *Ilybius* to the tribe Agabini. Zimmermann (1935) (followed by Zaitzev, 1953) placed *Ilybius* in the tribe Colymbetini due to the unequal metatarsal claws and the apically lobed metatarsomeres in contrast with the equal metatarsal claws and non-lobed metatarsomeres of members of his tribe Agabini. However, he did point out that species of *Ilybius*, like members of the tribe Agabini but unlike other members of Colymbetini, possessed a linear arrangement of short setae on the posteroapical angle of the metafemur. Balfour-Browne (1950) reviewed the characters of *Ilybius* and showed that a phenocline in the lobing of the hind tarsi could be found among members of the genera *Agabus* Leach and *Ilybius*, an observation made in a more general way by Sharp (1882). In addition, some *Agabus* species show an inequality in the relative lengths of the two metatarsal claws while some *Ilybius* species have metatarsal claws that are almost equal. *Carrhydrus crassipes* Fall, which has very unequal metatarsal claws, has many affinities with members of *Agabus* s. str. (Leech, 1942; Larson, 1975) and probably represents a sister group of this subgenus. Metatarsal claw length is unstable even between closely related forms. Sharp (1882:891) noted that in characters of the hind legs of *Ilybius* species "there are scarcely two species which agree exactly in the size and form of their parts" (lobing of metatarsomeres, leg width, hind coxa and metasternal wings).

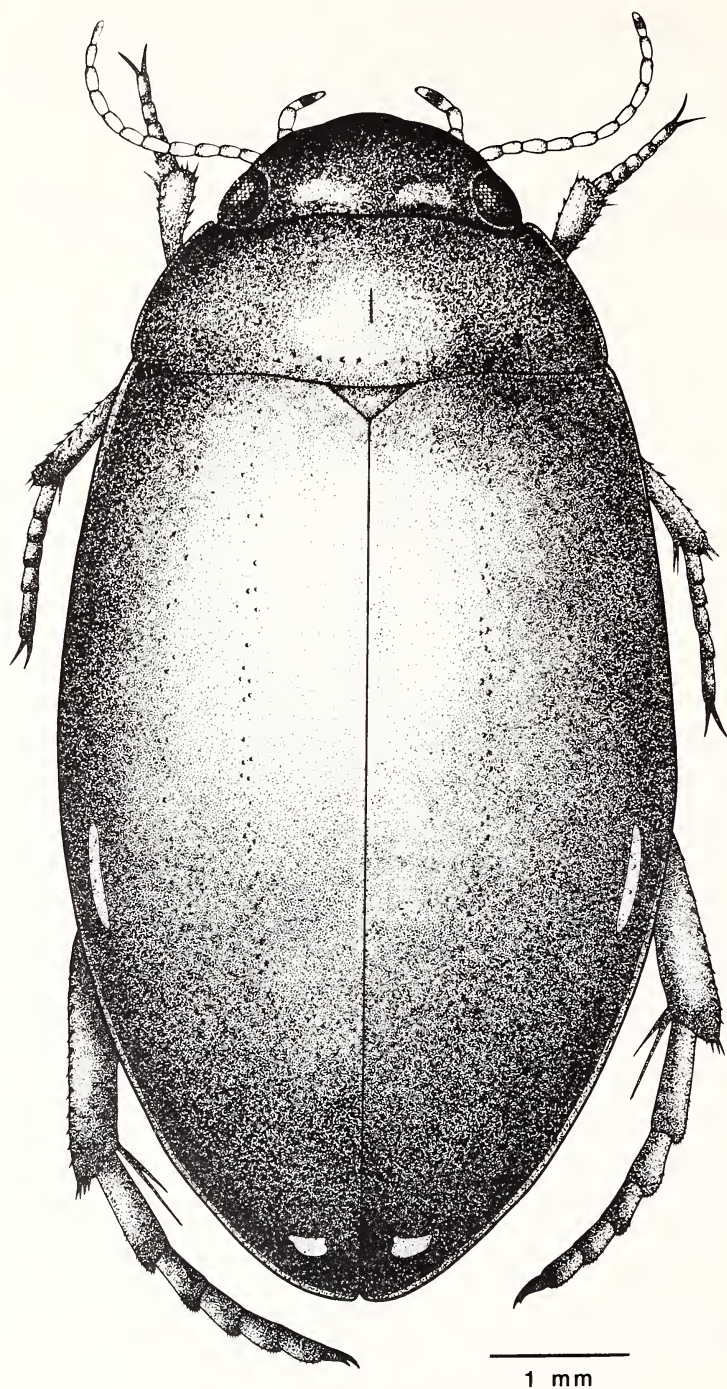


Fig. 1. Habitus of *Ilybius angustior* (Gyllenhal).



In fact, the great similarity between certain members of *Agabus* and *Ilybius* is exemplified by the holarctic *I. vittiger* (Gyllenhal), being treated as a species of *Agabus* until recently when it was independently recognized as a species of *Ilybius* by Larson and Roughley (1983) and Nilsson (1983).

There is strong similarity between adults of *Ilybius* and *Agabus* in the structure of the proventriculus (Balfour-Browne, 1934), pleurites of abdominal segment 2 (Leech, 1942), and wing venation (Goodliffe, 1939). Dettner (1985) placed *Ilybius* in the Colymbetini, but the pygidial gland constituents he listed for *Ilybius* species show as much similarity to those of various *Agabus* and *Platambus* Thomson species as they do to any member of the Colymbetini. However, Dettner found *Ilybius* to be characterized by the possession of tiglic acid as one the pygidial gland components, further emphasising the isolated position of the genus.

Brinck (1948) reviewed morphological characters used in the classification of the genera of Colymbetinae and demonstrated that no single character has been discovered that will define adults of the tribe Agabini or Colymbetini. Nevertheless, he concluded that the weight of evidence indicated a closer relationship of *Ilybius* with *Agabus* than with any members of the tribe Colymbetini.

A close relationship between *Agabus* and *Ilybius* is also indicated by the larvae. Nilsson (1983) concluded "no character has been found for the separation of the larvae of these genera that is valid for all species and all three instars." Nilsson (1983) introduced the relative width of the sclerotized parts of the ventral surface of abdominal sternum 6 and relative positions of setae and stigmata as characters to separate 3rd instar larvae of *Agabus* and *Ilybius*. These characters are gradational, as are the ridging of the side of the head and the setae of the fore femur used by other authors (Balfour-Browne, 1950; Leech and Chandler, 1956; Galewski, 1966), and do not show sharp discontinuities between the groups.

I concur with Sharp (1882), Leech (1942), Brinck (1948) and Balfour-Browne (1950) in placing *Ilybius* in the tribe Agabini because of the general similarity in adult and larval structure between members of *Ilybius* and certain species of *Agabus*, and the shared possession of the metatibial comb which is not found in a similar form among members of the tribe Colymbetini.

Within *Agabus*, it is the species of the *A. chalconatus* group of Zimmermann (1935) that appear most similar to members of *Ilybius*. Among these species, the metatarsi are relatively broad, the posteriolateral angles of the metatarsomeres are more or less lobed and the metatarsal claws are slightly unequal and dissimilar in shape. In some species, notably *A. neglectus* Erichson, the basal two or three metatarsomeres are longitudinally impressed dorsolaterally so that a more or less evident convexity or ridge exists along the dorsolateral margin of the tarsomere, reminiscent of the externolateral beading of the metatarsomeres of males of many *Ilybius* species. *Agabus chalconatus* (Panzer) has sucker hairs on the inner face of the parameres as do many species of *Ilybius*. The character state is also found in a few other species of *Agabus* not belonging to the *A. chalconatus* group (Balfour-Browne, 1950). Other points of similarity exist between individual members of the *A. chalconatus* group and certain species of *Ilybius*, but no synapomorphy is known to indicate they are sister groups. The female gonocoxae, while elongate, sclerotized and with reduced setae in members of the *A. chalconatus* group, are not dorsally toothed and female sternum 6 is not medially emarginate as in all species of *Ilybius*. The ovipositor is uniform among members of *Ilybius* and consistently different from that of any other Colymbetinae.



With few exceptions, members of *Ilybius* share a characteristic habitus (Fig. 1) which, even in the field, provides a reliable guide for recognition. The species are of moderate size. The body is oval in dorsal aspect, generally widest behind the middle, and relatively strongly narrowed towards both the anterior and posterior ends: in the lateral aspect the beetles are strongly convex dorsally and flattened ventrally. The color is usually dark although many specimens have the lateral margins of the body and the appendages variously paler. A medial sublateral pale vitta and a subapical pale spot are generally present on each elytron. The pale markings may not be visible on all specimens either because the pale areas are very faint and only discernable when the elytron is lifted and examined against a light, or because the lateral pale areas are expanded mesad to incorporate the pale spots. Also, such maculations are characteristic of a number of other agabines.

The single best generic character is the structure of the female genitalia. A saw-like ovipositor is formed by the gonocoxae which are laterally flattened, sclerotized and narrowly triangular in shape with the dorsal surface of the pointed apex bearing a row of prominent teeth (Jackson, 1960; Burmeister, 1976). Associated with this form of ovipositor is an emargination of the posteriomedial portion of sternum 6, presumably to permit extrusion of the gonocoxae and permit their vertical movement. The form of the ovipositor so perfectly resembles a key-hole saw that an immediate conclusion is that it functions to cut slits into substrates in which eggs are deposited. In fact, this has been observed by Jackson (1960) who described the structure of the ovipositor and mechanism of oviposition which involves depositing eggs into slits cut into the stems of aquatic plants.

The homogeneity of the genus shows in its nomenclatural history. Since Erichson (1832), there have been few generic synonyms proposed and little confusion in species placement. Although I have not examined the type species, the Palaearctic genus *Colymbinectes* Falkenstrom, 1936, appears very similar to species of *Ilybius* and was considered to be a synonym of *Ilybius* by Gschwendtner (1939). Zaitzev (1953) recognized *Colymbinectes* but admitted specimens differed from those of *Ilybius* only in their broader hind tarsi. However, Brinck (1948) reported that the gonocoxae of *Colymbinectes* differ from those of *Ilybius* so that *Colymbinectes* is not a synonym of *Ilybius*. The remaining genus group names listed in the following synonymy were all proposed for subgenera.

Although the high level of similarity among species has facilitated generic assignment of species, it has caused considerable difficulty in species recognition. Fall (1927) and Wallis (1939) presented keys to the North American species with which it is possible to identify most males, but many females cannot be identified to species because intraspecific variation is greater than appreciated by those authors. The lack of extensive descriptions, illustrations and reference to genitalic characters makes these works difficult to use. The key to species presented by Larson (1975) included new characters and was augmented by descriptions, but covered only part of the North American fauna.

#### ECOLOGY OF *ILYBIUS*

Larson (1975) and Larson and Colbo (1983) described the habitats of adults of northern and western species, but nothing has been published on the habitats of several eastern North American species. Adults are primarily lentic in habitats which

range from tiny bog pools to the protected shorelines of large lakes (Larson, 1985; Ranta, 1985). Although some species occur in habitats that dry for short periods of time, no North American species is typically an inhabitant of short-lived water bodies such as vernal ponds. Larson (1985) observed that the species of northwestern North America tend to be segregated along gradients seemingly correlated with temperature and seasonal history of water bodies and with major terrestrial vegetation types.

Considerably more is known about the life history of European species, due especially to the work of Balfour-Browne (1950), Jackson (1960), Galewski (1966) and Nilsson (1981, 1983, 1986). The life histories of all European species follow a pattern unique among agabines. Nilsson (1986) describes the life history as semivoltine, proceeding as follows: eggs laid in summer hatch quickly into overwintering larvae which pupate the next spring or summer and develop into adults which overwinter before ovipositing in their third summer. Both adults and larvae can be found together over much of the year. Larvae overwinter in ponds while at least some adults apparently overwinter on land (Wesenberg-Lund, 1912; Jackson, 1960). Life history patterns may vary geographically. Dr. Wm. Hilsenhoff (1986, in litt.) has found, over many years of water beetle collecting in Wisconsin, few adult specimens of *Ilybius* in the spring until June which was the month in which he collected most specimens. Also, the vast majority of teneral adults were collected in June. Adult collections then gradually declined over the summer. Hilsenhoff interprets this pattern as indicating a univoltine life cycle with adults emerging in late spring, then mating and ovipositing in summer. The majority of adults then apparently die although some adult overwintering occurs. Larvae hatch in summer and fall and overwinter.

Larvae of all holarctic species have been described (Galewski, 1966; Nilsson, 1981, 1982, 1983). Larvae of the endemic nearctic species are unknown.

#### METHODS AND MATERIALS

The methods and taxonomic terms used are those of Larson (1975). Species are recognized on the basis of discontinuities in the distribution of character states. The members of several species pairs differ subtly in only two or three characters. However, as these differences were observed to be consistent within areas of sympatry, it was interpreted that maintenance of difference was due to genetic isolation of species. Geographical variation in certain characters was observed in several species, but in no instances were geographical populations of a species sharply enough delimited morphologically to be given formal infraspecific ranking.

Measurements important for species recognition are:

- total length (L)—measured from apex of clypeus to apex of elytra;
- width (W)—maximum width of body across elytra: the ratio L/W is used as an index of shape;
- width of metasternum (WS)—the side piece of the metasternum is wing-shaped and is referred to as the metasternal wing. The measurement is taken across the metasternum at point of closest approximation of mesocoxal cavity to metacoxa. This measurement does not include width of the narrow bead around the mesocoxal cavity, in this respect differing from measurements given earlier (Larson, 1975; Larson and Roughley, 1983). Change in measurement was adopted because leg position and dirt on the specimen less frequently obscure the reference

point for measurement when the mesocoxal bead is excluded. The coxal bead is rather uniform among species and does not offer useful characters;

- width of metacoxa (WC)—measured along an extension of line along which measurement WS was taken. The relative widths of WS and WC are expressed as the ratio WC/WS. Values for ratios are a little larger than those previously published because of the change in the measurement of WS.

Literature references are restricted to citations of original descriptions of North American and select Palaearctic taxa, comprehensive studies on the genus, and recent papers. Much of the early Palaearctic literature and synonymy is cited by Zimmermann (1920) and Balfour-Browne (1950).

The genus is well represented in North American collections. The majority of specimens examined came from the Canadian National Collection, Ottawa (CNC), California Academy of Sciences, San Francisco (CAS), and the United States National Museum, Washington (USNM). Additional specimens were examined from:

Academy of Natural Sciences of Philadelphia (ANSP);  
British Museum (Natural History), London (BMNH);  
B. & J. Carr Collection, Calgary (CARR);  
C. Chantal Collection, Sept-Iles (CHANT);  
Memorial University of Newfoundland, St. John's (MUN);  
Museum of Comparative Zoology, Harvard University (MCZ);  
New Mexico State University, Las Cruces (NMSU);  
Nova Scotia Provincial Museum, Halifax (NSPM);  
Old Dominion University, Norfolk, Virginia (ODU);  
Peabody Museum, Yale University (PMYU);  
Royal Ontario Museum, Toronto (ROM);  
Cook College, Rutgers University, New Brunswick, New Jersey (RU);  
University of Alberta, Strickland Museum, Edmonton (UASM);  
University of British Columbia, Vancouver (UBC);  
University of Montreal Collection, Montreal (UMC);  
Zoologische Staatssammlung, Munich (ZSM).

An attempt was made to examine all North American types. However, the following types could not be located: *I. biguttulus* Germar (repository not located); *I. confusus* Aubé and *I. quadrimaculatus* Aubé (specimens searched for in Institut Royal des Sciences Naturelles de Belgique but not located); and *I. viridianeus* Crotch (not located in either ANSP or MCZ collections).

Collection records for all species are indicated on distribution maps, but, in order to save space, detailed collection data are not presented. These data are available from the author on request. An emphasis was placed on examination of specimens from Canada and the northeastern portion of the continent as these are the regions in which the major taxonomic problems were noted. The treatment of the genus in the western United States is somewhat cursory as there appear to be only a few well defined species in the region.

The BMNH, CAS, CNC, MUN and UASM also contain specimens of palaearctic *Ilybius*, of which I examined specimens of: *I. aenescens* Thomson, 1870; *I. angustior* (Gyllenhal, 1808); *I. apicalis* Sharp, 1873; *I. ater* (DeGeer, 1774); *I. cinctus* Sharp,



1882; *I. crassus* Thomson, 1856; *I. fenestratus* (Fabricius, 1781); *I. fuliginosus* (Fabricius, 1792); *I. guttiger* (Gyllenhal, 1808); *I. lateralis* (Gebler, 1832); *I. meridionalis* Aubé 1838; *I. obtusus* Sharp, 1882; *I. quadriguttatus* (Lacordaire, 1835); *I. similis* Thomson, 1856; *I. subaeneus* Erichson, 1837; *I. vittiger* (Gyllenhal, 1827) and *I. weymarni* Balfour-Browne, 1947.

*Ilybius* Erichson, 1832

*Ilybius* Erichson, 1832:18, 34. Type species *Dytiscus fenestratus* Fabricius, 1781:294, designated by Westwood, 1838:8.

*Ilyobius* Gemminger and von Harold 1868:451 (unjustified emendation of *Ilybius* Erichson).

*Idiolybius* des Gozis, 1886:8. Type species *Dytiscus fenestratus* Fabricius, 1781:294.

*Agabidius* Seidlitz, 1887:97. Type species *I. cinctus* Sharp 1882:560, designated by Guignot 1948:169.

*Ilybidius* Guignot, 1948:167. Type species *I. discedens* Sharp, 1882:557, by monotypy.

KEY TO ADULTS OF NEARCTIC SPECIES OF *ILYBIUS*

- I. Pro- and mesotarsomeres 1–3 slightly broadened and bearing long-stalked, oval suckers beneath: sternum 6 with hind margin broadly rounded, truncate or slightly concave but not narrowly emarginate medially ..... Key A, males
- II. Pro- and mesotarsomeres lacking ventral suckers: sternum 6 with a narrow medial emargination or notch on hind margin ..... Key B, females

KEY A. MALES

- 1. Metatarsomeres 1 to 4 each with a ridge along dorsoexternal margin ..... 2
- Metatarsomeres lacking ridge or bead ..... 7
- 2(1). Sternum 6 with a number of coarse longitudinal rugae or striae on posterior surface, setiferous punctures more or less obscured by rugae; a narrow, longitudinal posteriomedial keel present or not ..... 3
- Sternum 6 more or less smooth or faintly rugose along posterior margin, setiferous punctures evident; a longitudinal posteriomedial keel present ... *pleuriticus* LeConte
- 3(2). Sternum 6 with a posteriomedial keel: antenna with at least apical flagellomere infuscate medially ..... 4
- Sternum 6 lacking posteriomedial keel but posterior surface with strong longitudinal rugae: antenna entirely yellow, without apical infuscation ... *subaeneus* Erichson
- 4(3). Metatibia with coarse punctation restricted to basal 1/3 to 1/2, remainder of ventral face finely punctate: aedeagus with apex spear-shaped in dorsal aspect (Fig. 70) ..... *quadrimaculatus* Aubé
- Metatibia with coarse punctation along length of ventral face: aedeagus evenly narrowed to apex ..... 5
- 5(4). Size small, L—7.1 to 8.6 mm (population means < 8.0); metasternal wing narrow, WC/WS—2.4 to 3.6 ( $\bar{x}$  > 2.6); body narrow, L/W—1.89 to 2.07 ( $\bar{x}$  > 1.94): aedeagus slender (Fig. 68): body shiny black or some specimens distinctly aeneous: low arctic west of Hudson Bay ..... *churchillensis* Wallis
- Larger, L—7.5 to 10.2 mm ( $\bar{x}$  > 8.0 mm); metasternal wing broad, WC/WS—2.0 to 3.2 ( $\bar{x}$  < 2.6); body broader, L/W—1.82 to 2.03 ( $\bar{x}$  < 1.95): aedeagus broad (Figs. 67, 69): body shiny to dull black, never aeneous: low arctic to boreal ..... 6



- 6(5). Aedeagus tapering to a narrow, faintly reflexed apex (Fig. 67); dorsal metatarsal claw with ventral margin sinuate and slightly expanded medially (Fig. 53) ..... *angustior* (Gyllenhal)
- Aedeagus with apex shorter and more bluntly rounded (Fig. 69); dorsal metatarsal claw narrower, ventral margin not expanded medially ..... *picipes* (Kirby)
- 7(1). Sternum 6 with a posteriomedial longitudinal keel ..... 8
- Sternum 6 lacking a medial keel ..... 9
- 8(7). Size small, L—7.8 to 9.1 mm ( $\bar{x}$  < 9.0 mm); body narrow, L/W—1.89 to 2.07 ( $\bar{x}$  > 1.90); metacoxal plate with striae sparse and lightly impressed ..... *ignarus* LeConte
- Larger, L—8.9 to 11.5 mm ( $\bar{x}$  > 9.0 mm); body broader, L/W—1.77 to 1.95 ( $\bar{x}$  < 1.90); metacoxal plate densely and conspicuously striolate ..... *biguttulus* Germar
- 9(7). Metasternal wing narrow, WC/WS > 4.5 ..... *oblitus* Sharp
- Metasternal wing broader, WC/WS < 4.5 ..... 10
- 10(9). Sternum 6 with posteriomedial area smooth and more or less flattened, laterally with coarse longitudinal or oblique rugae; elytron with many intersections of lines of sculpture each bearing a puncture: paramere lacking adhesive setae: boreal to low arctic ..... 11
- Sternum 6 broadly rounded apically, lacking sublateral rugae; elytron lacking small punctures at intersections of lines of sculpture: paramere with or without adhesive setae: southern boreal and south ..... 12
- 11(10). Sternum 6 with apex truncate or sinuate medially; aedeagus very large with apex reflexed (Fig. 59); prosternal process normal, elongate; metasternal impression reaching level of hind margin of mesocoxae: boreal, transcontinental ..... *discedens* Sharp
- Sternum 6 with apex broadly rounded: aedeagus shorter, apex not reflexed (Fig. 60); prosternal process short, metasternal impression not reaching level of hind margin of mesocoxae: low arctic, west of Hudson Bay ..... *vittiger* (Gyllenhal)
- 12(10). Metasternal wing broad, WC/WS < 2.9: paramere lacking sucker setae on mesal face: aedeagus with a small apical hook (Fig. 61) ..... *fraterculus* LeConte
- Metasternal wing narrower, WC/WS > 2.8: paramere with sucker setae on mesal face: aedeagus with apex simple (Figs. 64, 65) ..... 13
- 13(12). Length 8.7 to 10.0 mm; metasternal wings broad, WC/WS—2.80 to 3.45 ..... *incarinatus* Zimmermann
- Length 9.7 to 11.0 mm; metasternal wings narrower, WC/WS—3.40 to 4.10 ..... *confusus* Aubé

## KEY B. FEMALES

1. Metatibia with posterior margin and metatarsomeres 1 to 3 with outer margins bearing long, brown natatorial setae ..... *discedens* Sharp
- Metatibia and metatarsomeres lacking such setae ..... 2
- 2(1). Elytron with intersections of lines of sculpture each with a small puncture: prosternal process short, metasternum with anteromedial impression small and not extending posteriorly to level of hind margin of mesocoxae: low arctic, west of Hudson Bay ..... *vittiger* (Gyllenhal)
- Elytron without evident punctures at intersections of lines of sculpture: prosternal process various but most specimens with metasternal impression extending posteriorly to level of hind margin of mesocoxal cavities ..... 3
- 3(2). Antenna with at least apical flagellomere infusate medially (many specimens with infuscation more expanded on antenna and labial palpus) ..... 4
- Antenna and palpi entirely yellow or pale reddish and devoid of infuscation ... 7

- 4(3). Metatibia with ventral face finely and sparsely punctate on distal  $\frac{1}{2}$  to  $\frac{2}{3}$ , more coarsely punctate at base: size larger, L—9.4 to 11.1 mm: western ..... *quadrimaculatus* Aubé
- Metatibia with coarse punctures along length of ventral face (size and density of punctures may decrease distally on some specimens): smaller, L—7.1 to 10.2 mm: boreal to low arctic ..... 5
- 5(4). Size smaller, L—7.1 to 8.6 mm (population means < 8.0 mm); metasternal wing narrow, WC/WS—2.40 to 3.30 ( $\bar{x}$  > 2.60); body narrow, L/W—1.89 to 2.07 ( $\bar{x}$  > 1.94): body shiny black or some specimens distinctly aeneous: low arctic west of Hudson Bay ..... *churchillensis* Wallis
- Larger, L—7.5 to 10.2 mm ( $\bar{x}$  > 8.0 mm); metasternal wing broader, WC/WS—2.00 to 3.20 ( $\bar{x}$  < 2.60); body broader, L/W—1.82 to 2.03 ( $\bar{x}$  < 1.95): body shiny to dull black, at most faintly aeneous: low arctic to boreal ..... 6
- 6(5). Gonocoxa, in lateral aspect, with dorsal margin almost straight or only broadly and evenly concave proximad of distal teeth ..... *picipes* (Kirby)
- Gonocoxa with dorsal margin strongly subbasally sinuate or emarginate ..... *angustior* (Gyllenhal)
- 7(3). Metatibia with coarse punctures along length of ventral face (size and density of punctures may decrease distally on some specimens) ..... 8
- Metatibia with apical  $\frac{1}{2}$  to  $\frac{2}{3}$  of ventral face only finely and sparsely punctate ... 9
- 8(7). Sternum 6 with marginal bead obsolete on outer angle of medial emargination (Fig. 30): elytron with meshes of primary sculpture relatively large and irregular in shape with some fusion of adjacent meshes (Fig. 12): L—10.6 to 12.6 mm ... *pleuriticus* LeConte
- Sternum 6 with marginal bead continuous around lateral angle of medial emargination (Fig. 31): elytron with primary meshes of sculpture smaller and more regular in size and shape (Fig. 13): most specimens with dorsal surface distinctly aeneous: L—9.1 to 11.0 mm ..... *subaeneus* Erichson
- 9(7). Metasternal wing narrow, WC/WS > 4.5 ..... *oblitus* Sharp
- Metasternal wing broader, WC/WS < 4.5 ..... 10
- 10(9). Small, L—7.8 to 9.1 mm ( $\bar{x}$  < 9.0 mm); elongate, L/W—1.89 to 2.07 ( $\bar{x}$  > 1.90): metacoxal plate with striae separate, sparse and lightly impressed: color black with lateral margins piceous or at most narrowly reddish: elytron basomedially with meshes of sculpture small, irregular and not or only slightly longitudinally stretched ..... *ignarus* (LeConte)
- Larger, L—8.4 mm or greater; body broader, L/W—1.73 to 1.98 ( $\bar{x}$  < 1.90): metacoxal plate with striae well developed and intersecting: color various: elytral sculpture various ..... 11
- 11(10). Sternum 6 with posteriomarginal emargination deep (Fig. 26): metasternal wings broad, WC/WS—2.3 to 3.0: elytron basomedially with at least some meshes of primary sculpture strongly longitudinally stretched: transcontinental but only common on Great Plains and west ..... *fraterculus* LeConte
- Sternum 6 with medial emargination shallower (Fig. 27): metasternal wing broader, WC/WS—2.55 to 4.10, but if less than 2.80, meshes of elytral sculpture not or only slightly stretched (no meshes more than 3× as long as wide): Rocky Mountains and east but only common east of Great Plains ..... 12
- 12(11). Elytron with meshes of primary sculpture more rounded, few or no meshes more than 3× as long as wide (Fig. 4) ..... *biguttulus* Germar
- Elytron basosuturally with many meshes strongly elongated and more than 3× as long as wide (Figs. 6, 7) ..... 13
- 13(12). Length—8.7 to 10.0 mm: WC/WS—2.80 to 3.40 ..... *incarinatus* Zimmermann
- Length 9.7 to 11.0 mm: WC/WS—3.30 to 4.10 ..... *confusus* Aubé

## SPECIES ACCOUNTS

*Ilybius discedens* Sharp, 1882

*Ilybius discedens* Sharp 1882:557. (Type area—"Hudsons Bay." Lectotype in BMNH, selected by Larson, 1975.)

*Selected reference.* Larson 1975:372.

*Description.* A small species in which males tend to be larger than females: L—7.10 to 9.03 mm; L/W—1.80 to 2.00. Measurements and ratios for selected population samples are given in Table 1.

Color of body dark, mainly black without metallic sheen. Head with frontal spots, labrum and anterior margin of clypeus rufous; lateral margin of pronotum and elytron at most faintly piceous; elytron with sublateral and subapical pale spots evident on most specimens. Palpi entirely rufous. Antenna yellow except apical flagellomere darkened medially and apically. Legs dark rufous to piceous.

Elytron with characteristic sculpture (Fig. 2) of small irregular meshes which bear fine secondary reticulation (may be somewhat effaced basomedially); small punctures present at intersections of lines and a few scattered punctures also present on some meshes.

Prosternum and prosternal process with ventral margin concave medially between procoxae in lateral aspect, medial convexity of prosternum somewhat swollen or inflated anteriorly; prosternal process strongly tectiform and not explanate basally, basal bead of more or less uniform width behind procoxae; apex acuminate apically but short. Metasternal impression attaining level of hind margin of mesocoxal cavities. Metasternal wings relatively narrow (WC/WS—2.85 to 4.11) but with a relatively high degree of intraspecific variation.

Metacoxal plate with striae shallow, sparse and more or less separated; shallow punctures present but somewhat obscured by microreticulation. Metacoxal lines strong, slightly sinuate anteriorly, traceable to metasternum.

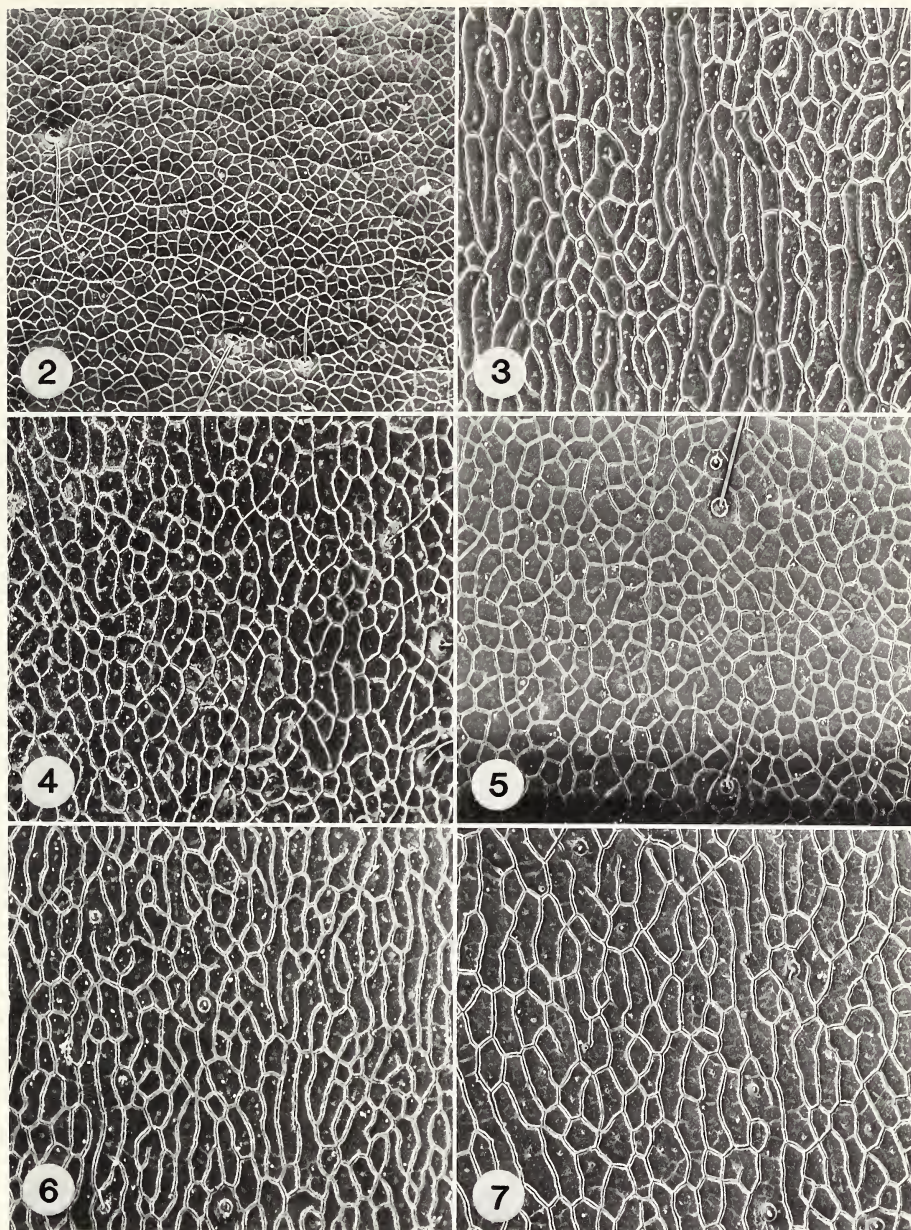
Metafemur with ventral face finely punctate, striae absent. Metatibia with a few coarse punctures basally on ventral face, otherwise impunctate or with only a few very fine punctures. Longer metatibial spur subequal in length to metatarsomere 1. Metatarsomere 1 lacking ventrolateral setae.

Table 1. Measurements and ratios of selected population samples of *Ilybius discedens* Sharp.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Newfoundland, pooled, ♂	20	8.51 (0.24) 8.00–9.03	4.41 (0.12) 4.22–4.74	1.93 (0.03) 1.89–2.00	3.48 (0.19) 3.03–3.78
Newfoundland, pooled, ♀	20	8.14 (0.26) 7.55–8.50	4.20 (0.12) 4.00–4.37	1.94 (0.03) 1.89–1.98	3.57 (0.17) 3.27–4.00
S. Labrador, ♂	20	8.13 (0.36) 7.55–8.73	4.27 (0.21) 3.92–4.59	1.91 (0.03) 1.85–1.98	3.54 (0.19) 3.21–4.00
S. Labrador, ♀	20	7.58 (0.23) 7.10–8.14	3.97 (0.16) 3.63–4.29	1.91 (0.04) 1.80–2.00	3.66 (0.22) 3.27–4.11
N. Alberta	20	8.20 (0.32) 7.68–9.04	4.32 (0.18) 4.08–4.80	1.90 (0.03) 1.85–1.96	3.18 (0.17)* 2.85–3.54

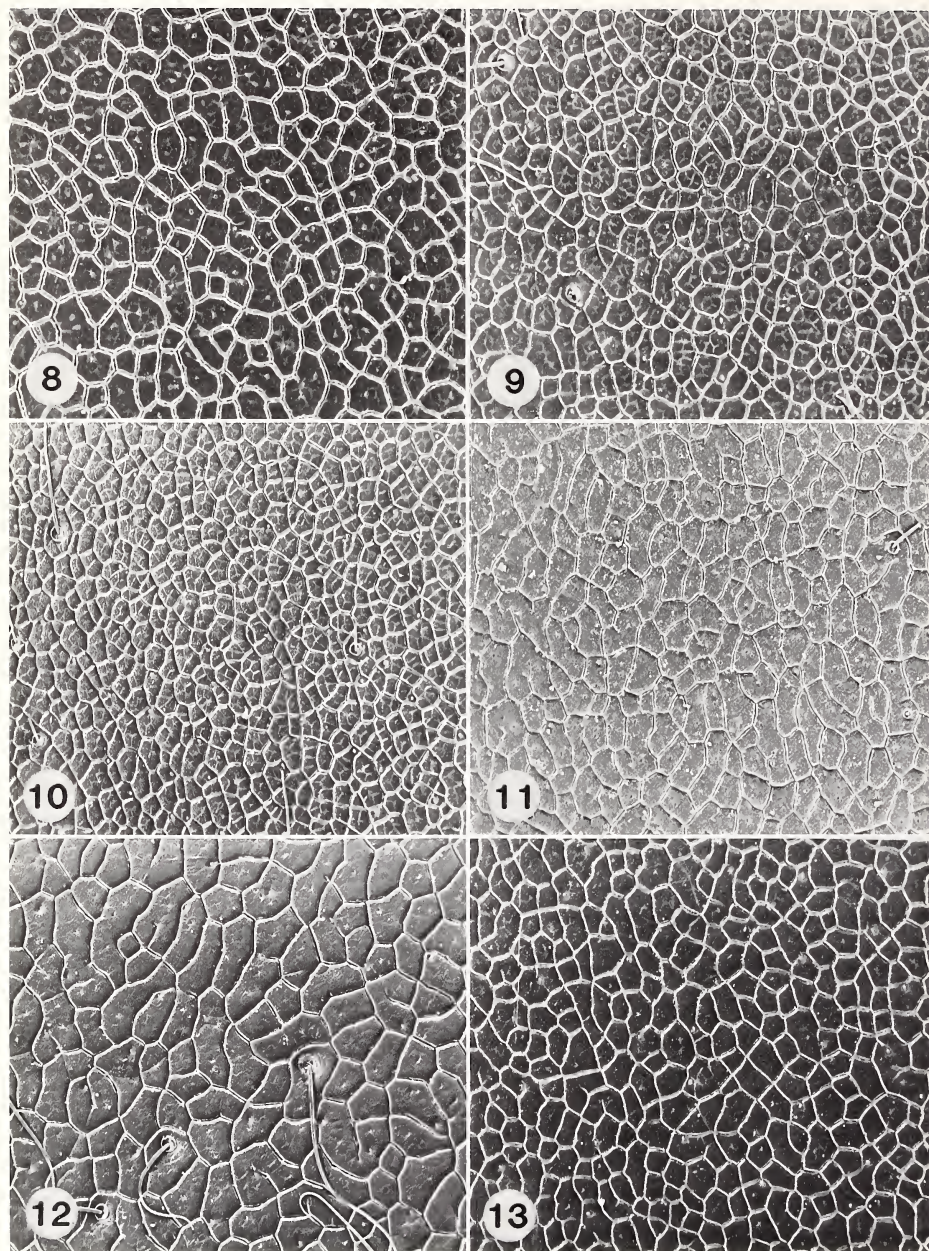
\* From Larson (1975), WS includes width of coxal rim.





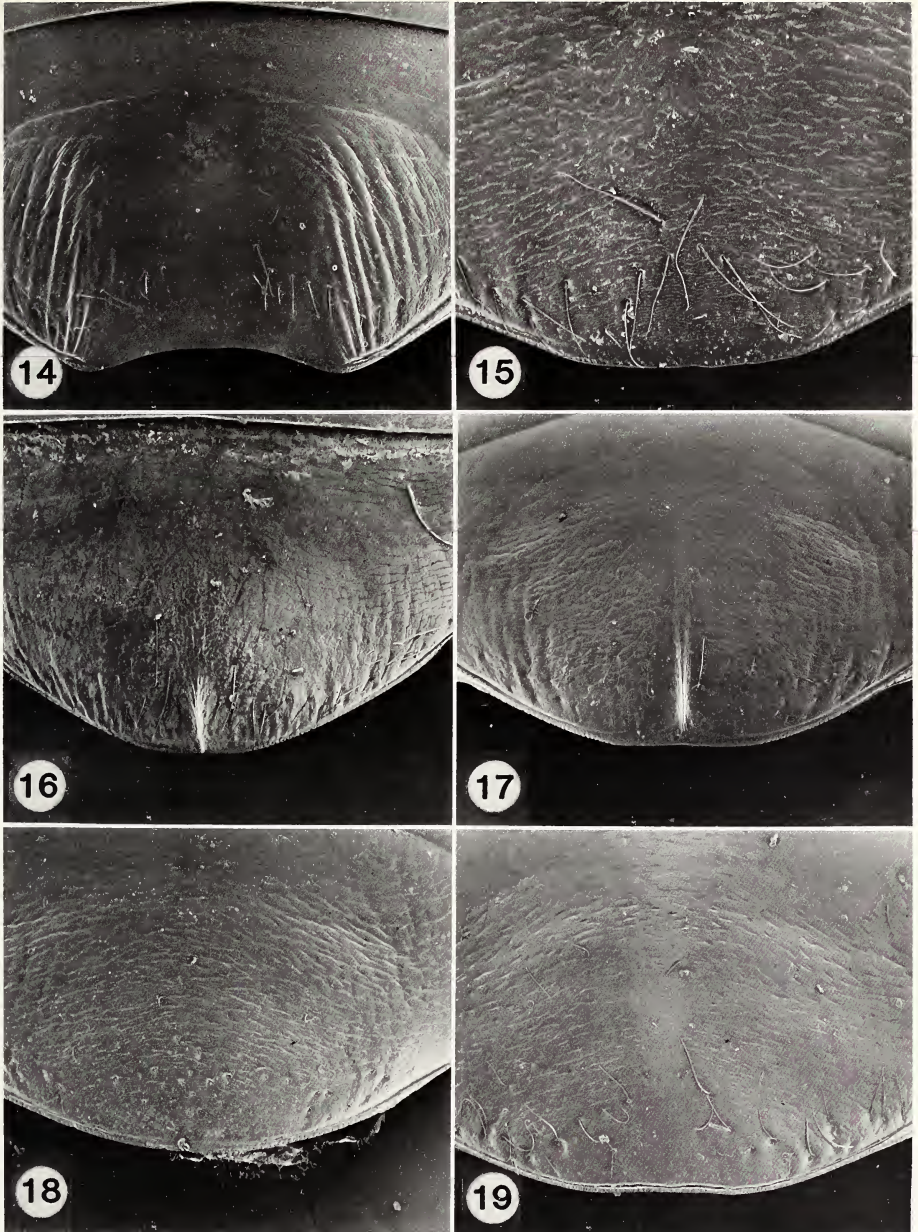
Figs. 2-7. Elytral microsculpture, basomedial area of disc. 2. *I. discedens*. 3. *I. fraterculus*. 4. *I. biguttulus*. 5. *I. ignarus*. 6. *I. incarinatus*. 7. *I. confusus*. Magnification  $\times 150$ .



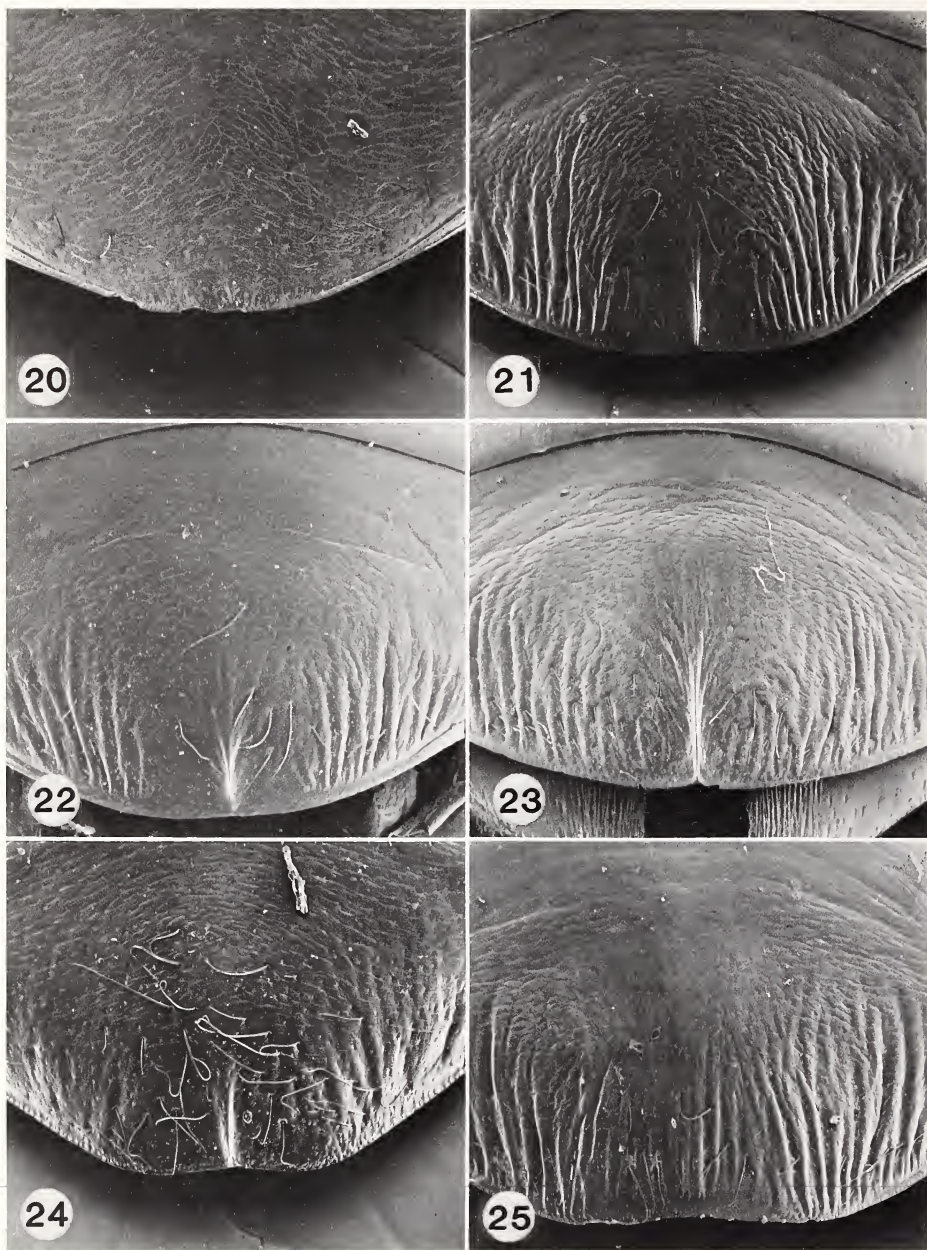


Figs. 8–13. Elytral microsculpture, basomedial area of disc. 8. *I. oblitus*. 9. *I. angustior*. 10. *I. picipes*. 11. *I. quadrimaculatus*. 12. *I. pleuriticus*. 13. *I. subaeneus*. Magnification  $\times 150$ .



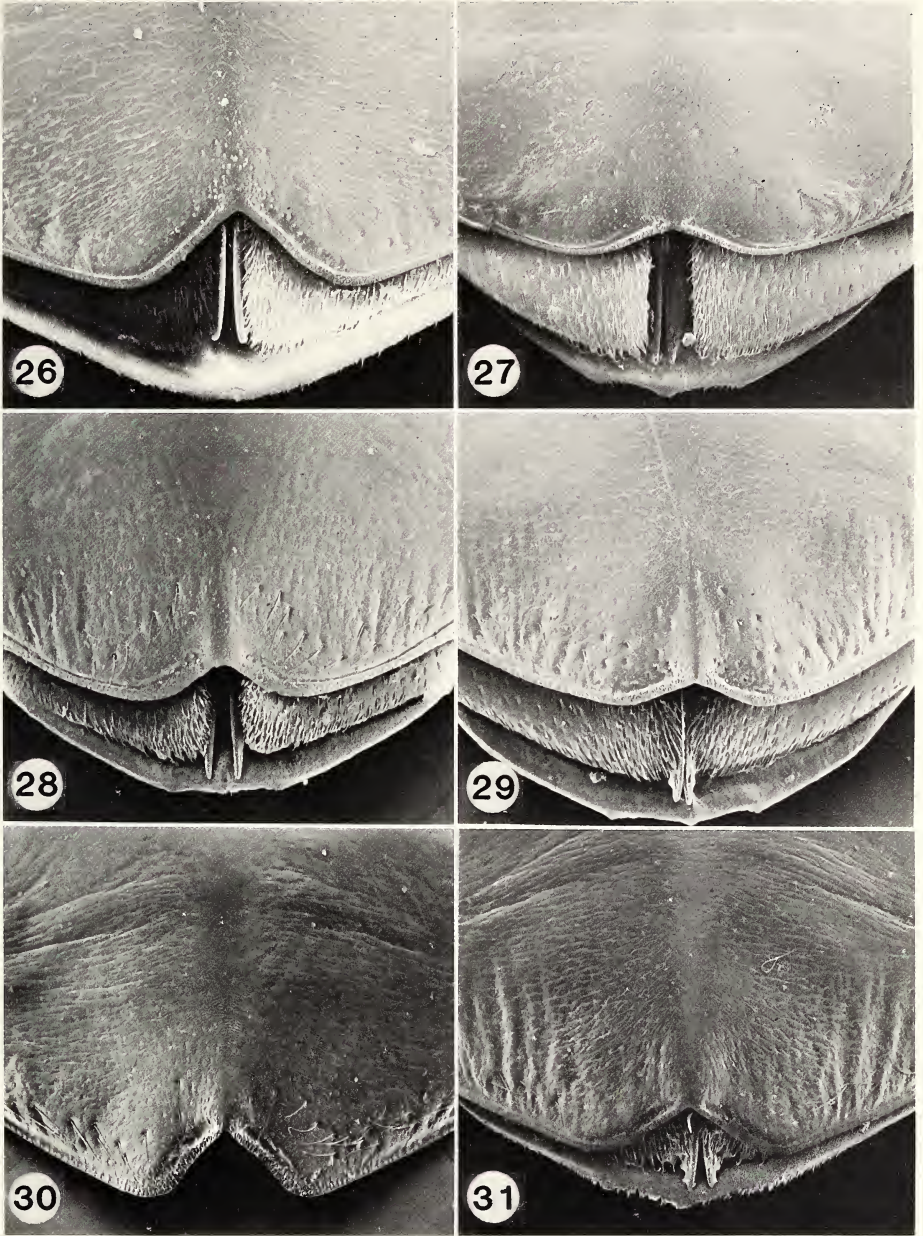


Figs. 14–19. Male sternum 6, ventral aspect. 14. *I. discedens*. 15. *I. fraterculus*. 16. *I. biguttulus*. 17. *I. ignarus*. 18. *I. incarinatus*. 19. *I. confusus*. Magnification  $\times 50$ .



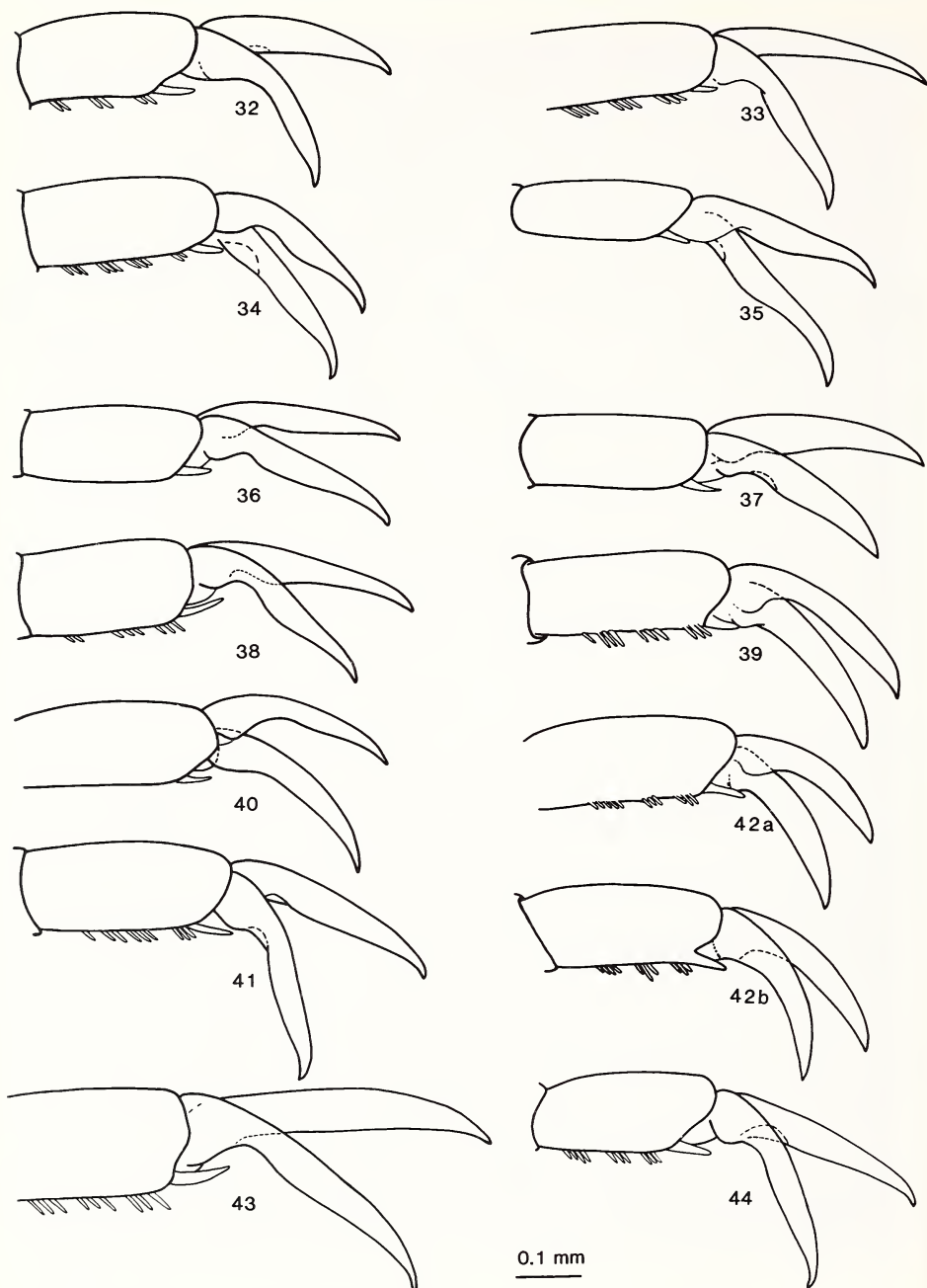
Figs. 20-25. Male sternum 6, ventral aspect. 20. *I. oblitus*. 21. *I. angustior*. 22. *I. picipes*. 23. *I. quadrimaculatus*. 24. *I. pleuriticus*. 25. *I. subaeneus*. Magnification  $\times 50$ .



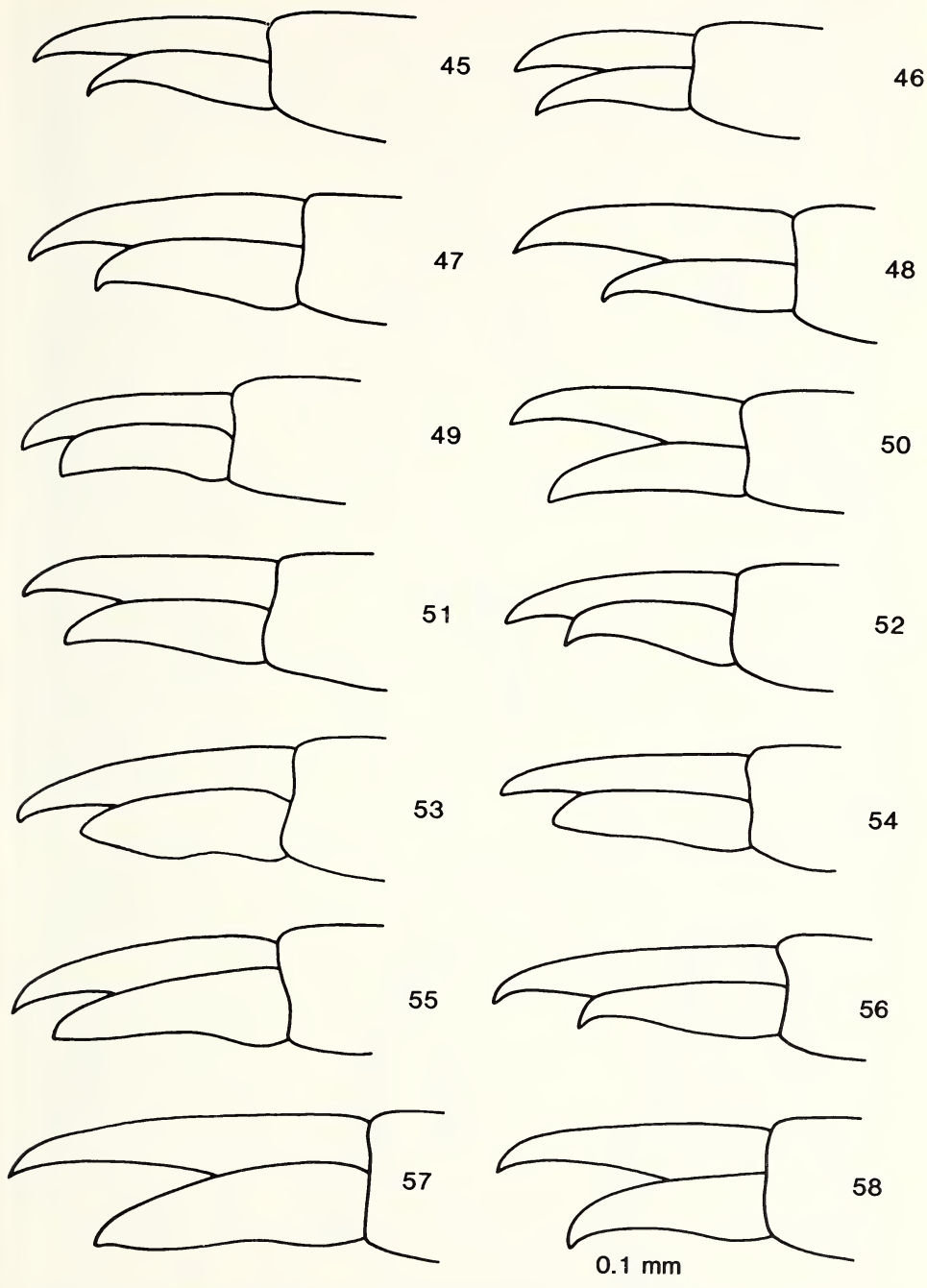


Figs. 26–31. Female sternum 6, ventral aspect. 26. *I. fraterculus*. 27. *I. confusus*. 28. *I. angustior*. 29. *I. quadrimaculatus*. 30. *I. pleuriticus*. 31. *I. subaeneus*. Magnification  $\times 50$ .

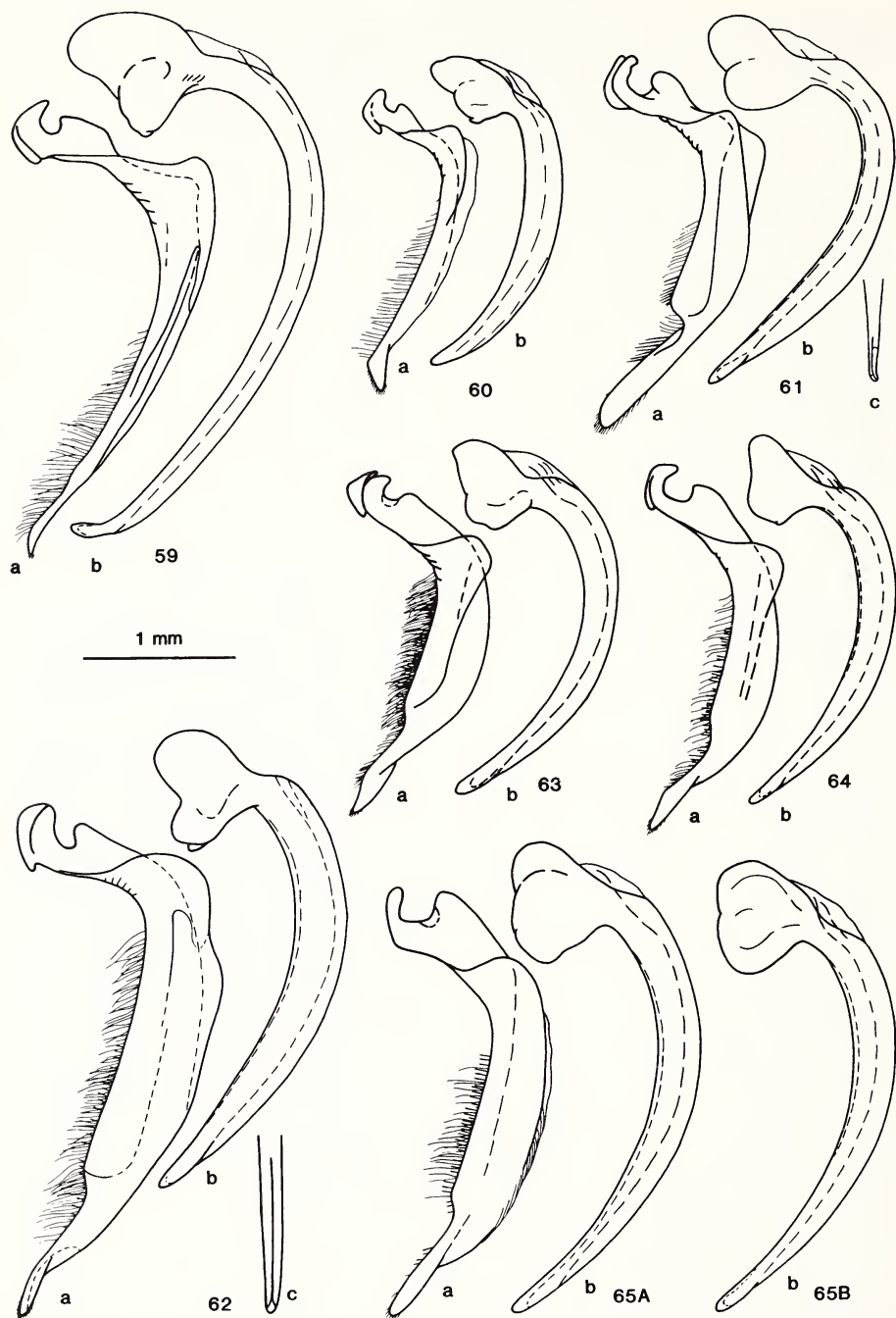




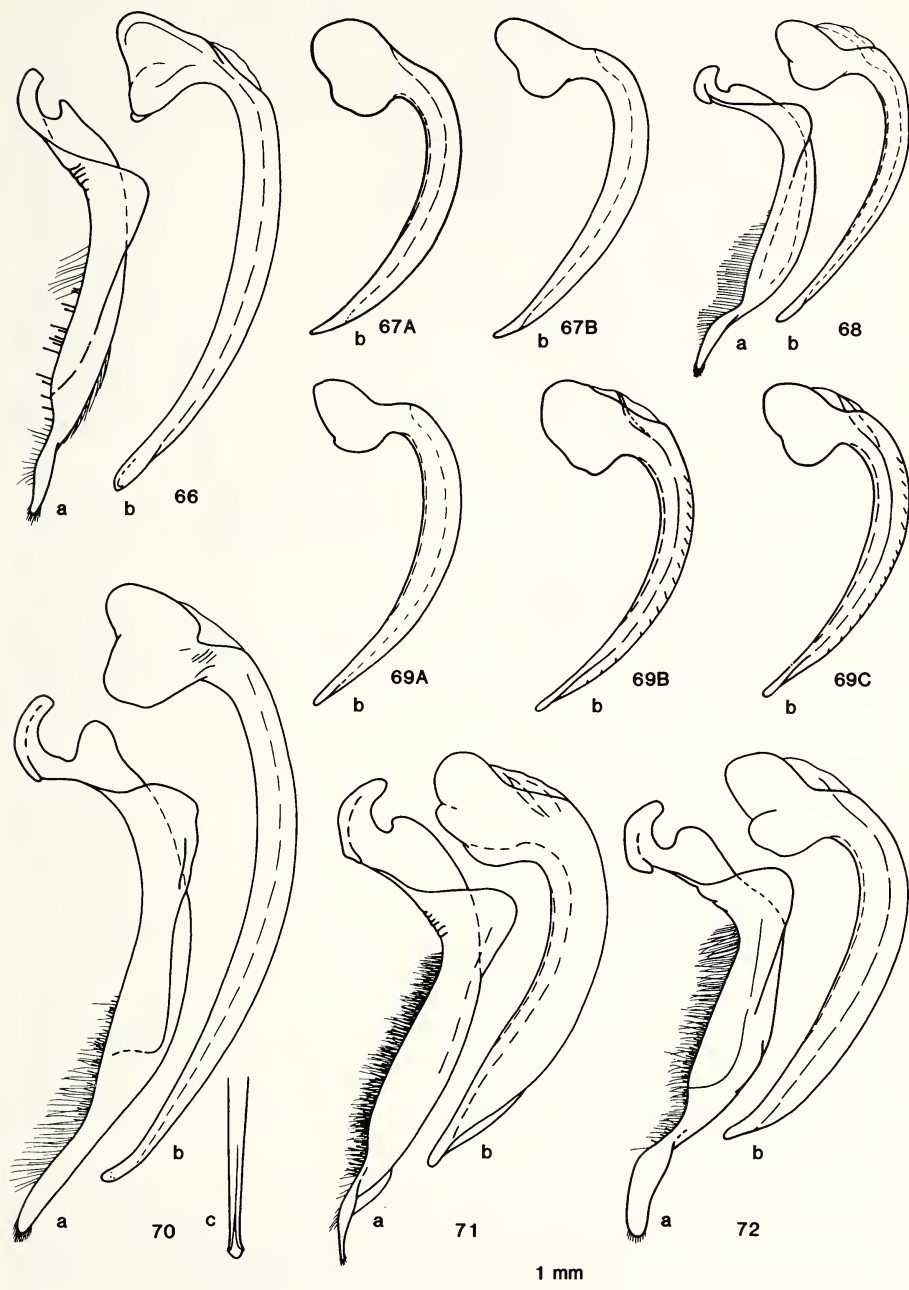
Figs. 32-44. Male, left protarsal claws, anterior aspect. 32. *I. discedens*. 33. *I. fraterculus*. 34. *I. biguttulus*. 35. *I. ignarus*. 36. *I. incarinatus*. 37. *I. confusus*. 38. *I. oblitus*. 39. *I. angustior*. 40. *I. churchillensis*. 41. *I. quadrimaculatus*. 42. *I. picipes*, a—Alaska, b—Ontario. 43. *I. pleuriticus*. 44. *I. subaeneus*.



Figs. 45–58. Male, left metatarsal claws, dorsal aspect. 45. *I. discedens*. 46. *I. vittiger*. 47. *I. fraterculus*. 48. *I. biguttulus*. 49. *I. ignarus*. 50. *I. incarinatus*. 51. *I. confusus*. 52. *I. oblitus*. 53. *I. angustior*. 54. *I. churchillensis*. 55. *I. picipes*. 56. *I. quadrimaculatus*. 57. *I. pleuriticus*. 58. *I. subaeneus*.



Figs. 59–65. Male genitalia: a—paramere, lateral aspect; b—aedeagus, lateral aspect; c—aedeagus apex, ventral aspect. 59. *I. discedens*. 60. *I. vittiger*. 61. *I. fraterculus*. 62. *I. biguttulus*. 63. *I. ignarus*. 64. *I. incarinatus*. 65. *I. confusus*, A—paratype of *I. denikei*, B—Specimen from Massachusetts.



Figs. 66-72. Male genitalia: a—paramere, lateral aspect; b—aedeagus, lateral aspect; c—aedeagus apex, ventral aspect. 66. *I. oblitus*. 67. *I. angustior*. 68. *I. churchillensis*. 69. *I. picipes*, A—specimen from Alaska, B—Ontario, C—Manitoba. 70. *I. quadrimaculatus*. 71. *I. pleuriticus*. 72. *I. subaeneus*.



**MALE:** Protarsal claws (Fig. 32) slender, especially posterior claw which is abruptly narrowed about middle. Metacoxae with posteriomedial keel absent or at most weakly developed. Metatarsomeres lacking a dorsolateral ridge or bead. Metatarsal claws (Fig. 45) with dorsal claw smoothly arcuate. Sternum 6 (Fig. 14) with apex broadly truncate or shallowly bisinuate: flat and smooth posteriomedially and longitudinally striate laterally, lateral bead absent across medial flattened area. Subgenital plate truncate apically, striate laterally but largely smooth medially: lateral sclerites longitudinally strigate. Male genitalia (Fig. 59) with paramere slender, setose on mesal margin but lacking sucker setae; aedeagus very elongate, longer than paramere, apex broadened and reflexed ventrally.

**FEMALE:** Secondary reticulation of elytron more strongly developed than on male, elytra of most specimens slightly duller than those of male. Metatibia with mesal margin and metatarsomeres along outer margin bearing elongate brown natatorial setae. Sternum 6 with lateral angles of apical emargination broadly rounded and semicircular, emargination compressed in posterior aspect, medially sternum raised into a low crest in lateral aspect with ventroapical margin right angled or produced as a small spine.

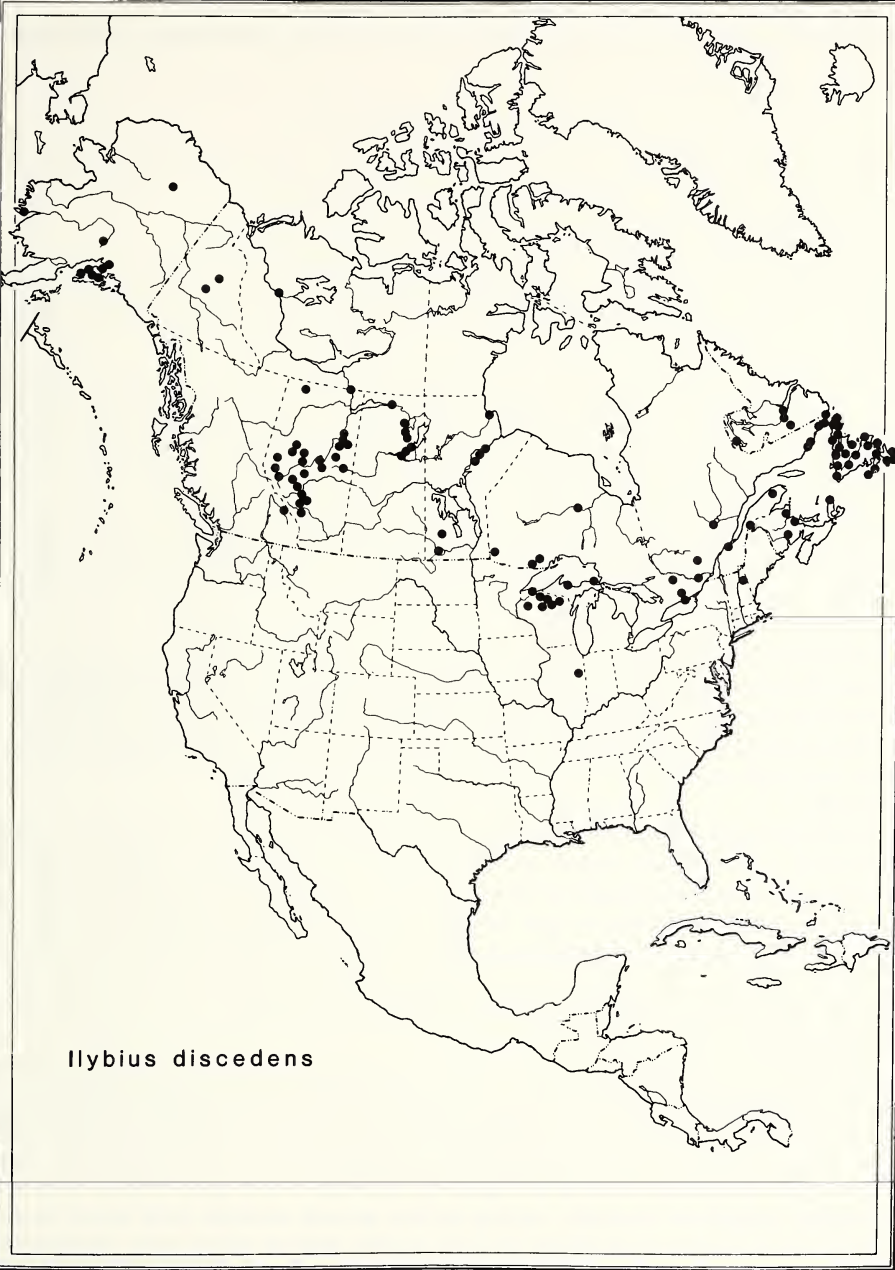
*Variation.* This species differs from other North American *Ilybius* in that the average size of males is greater than that of females (Table 1). This sexual size difference is especially pronounced in Labrador while in western North America the sexual size disparity is less noticeable.

The range of variation in the ratio WC/WS is large but does not show a geographical pattern. At least part of this large variation is an artifact created by expressing the character as a ratio, for a given numerical variation in a small denominator (WS) will produce a greater spread in values of the ratio than will the same amount of variation in a larger denominator.

*Nomenclature.* Data on the lectotype was given by Larson (1975).

*Classification notes.* This species occupies a rather isolated position within the genus because of the possession of several peculiar characters. The occurrence of natatorial setae on the metatibia and outer margins of the metatarsomeres of the female is unique within the genus and even among the members of the tribe Agabini with which I am familiar. The aedeagus is also distinctive, being exceptionally elongate relative to the body length and with the apex flattened and reflexed. On the other hand, the species possesses several plesiotypic characters, namely: simple parameres which lack sucker setae; and elytral sculpture with well developed punctures located at intersections of lines of primary sculpture. Larson and Roughley (1983) associated *I. discedens* with *I. vittiger* principally on these very characters, while recognizing that the two species differ in many other features. It appears more probable that the relationship between *I. discedens* and *I. vittiger* is not close and is based primarily on synplesiotypic features.

*Ecology.* This is one of the most characteristic water beetle species of boreal peatlands (Larson, 1985). The beetles occur in small, moss-ringed pools, often where the water is cold to the touch. The life history has not been investigated but because adults are common in the spring and teneral beetles are found primarily in July and August, it appears as though adult overwintering occurs regularly. Overwintering *Ilybius* larvae, presumably of *I. discedens*, have also been observed in small peat pools in Newfoundland. I have not seen records of flight.



Map 1. Collection localities for *Ilybius discedens*.

*Distribution.* *Ilybius discedens* has a wide distribution in the northern boreal portion of the nearctic region. The range extends from Newfoundland to western Alaska and from the northern limit of trees south into the northeastern United States (Map 1).

*Ilybius vittiger* (Gyllenhal, 1827)

*Dytiscus vittiger* Gyllenhal 1827:379. (Type area—"Laponiae borealis." Type in Museum of Zoology, Uppsala, Sweden. Type not seen.)

*Selected references.* Larson and Roughley, 1983. Nilsson, 1983.

*Description.* The habitus of this species is somewhat unusual for a member of *Ilybius*: the body is relatively depressed and broadly oval in outline, in this respect resembling a member of the genus *Agabus*. Size small, L—6.8 to 7.85 mm, L/W—1.75 to 1.93.

Color of body piceous to black dorsomedially, without metallic reflection. Head with labrum, anterior margin of clypeus and frontal spots, rufous to piceous. Pronotum narrowly piceous laterally. Elytron with lateral margin, or on some specimens entire disc, piceous. Antenna rufous or some specimens with apical antennomere faintly infusate. Palpi rufous. Legs rufous to rufopiceous.

Elytron with primary meshes of sculpture large, of very irregular shape and without distinct longitudinal stretching. Intersections of lines with small punctures, also small punctures located in many meshes. Secondary microreticulation present but on many specimens effaced basally.

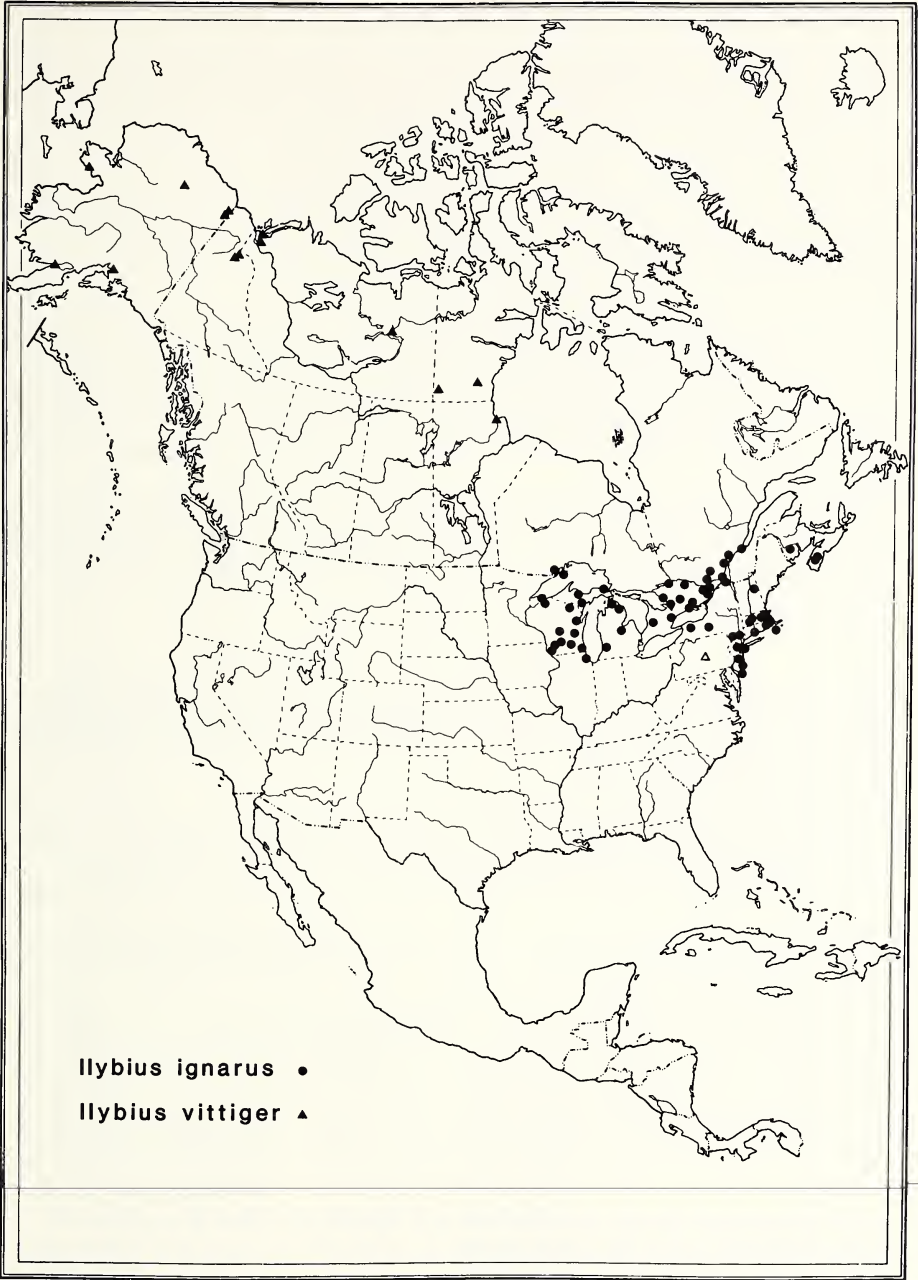
Prosternal process relatively short, tectiform: lateral bead not inflated behind procoxae. Metasternal impression short, its apex not attaining level of hind margin of mesocoxal cavities. Metasternal wings moderately narrow, WC/WS—2.75 to 3.67.

Metacoxal plate with striae lacking or weakly developed: its surface microreticulate and with poorly defined transverse rugae. Metacoxal lines traceable to metasternum.

Hind legs relatively narrow. Metafemur with small punctures but lacking striae. Metabibia with irregular coarse punctures on ventrolateral face, these punctures distributed along entire length of tibia or on many specimens becoming smaller or disappearing on distal third to half. Metatibial spurs subequal in length to metatarsomere 1. Metatarsomere 1 with one or more coarse setae along ventrolateral margin of most specimens. Metatarsal claws with only a slight disparity in size; dorsal claw with apex more arcuate than ventral claw, its apex not reaching as far distad as apex of ventral claw.

MALE: Protarsomeres 1 to 3 only slightly broadened, with a very small group of golden setae on ventroapical portion of each: protarsal claws slender, anterior and posterior each slightly sinuate ventrally. Metacoxae with a very small longitudinal keel along posterior portion of medial line. Metatarsomeres 1 to 3 lacking a dorso-lateral bead. Metatarsal claws as in Figure 46. Sternum 6 with apex broadly rounded or slightly emarginate medially: ventral surface smooth medially with lateral longitudinal rugae: lateral bead absent or only weakly defined across apex. Subgenital plate broad and slightly emarginate apically, it and lateral plates longitudinally rugose. Genitalia (Fig. 60) with paramere slender, lacking adhesive setae along mesal face. Aedeagus subequal in length to paramere, simple in form with apex narrowly rounded.

FEMALE: Metatibia along mesal margin and metatarsomeres along outer margin



Map 2. North American collection localities for *Ilybius vittiger* and *I. ignarus*. Open triangle represents a state record for *I. ignarus*.



lacking natatorial setae. Sternum 6 with a narrow medioapical emargination: medially with a prominent rounded ventral knob; laterally to knob with a few scattered coarse setiferous punctures, smaller micropunctures and, on most specimens, an area of prominent transverse or oblique microrugae: lateral bead complete along hind margin of sternum except where narrowly broken on crest of knob.

*Variation.* No pattern of geographic variation has been detected and North American specimens are similar to those from the western palaearctic.

*Classification notes.* The systematic position of this species has been discussed by Larson and Roughley (1983) and its placement in *Ilybius* also confirmed by Nilsson (1983). The species was postulated as being the sister species of *I. discedens* but the association proposed was based on plesiotypic characters (see below).

*Ecology.* Nilsson (1983) described the larva and discussed the ecology. The species occurs in the northern boreal and arctic portions of Fennoscandia where it inhabits small bog pools with sparse vegetation. It occurs in similar habitats in North America except it is known only from localities north of the tree line. Nilsson reports that this is an autumn-breeder with overwintering larvae. There are no North American records of flight.

*Distribution.* This species is holarctic in distribution, occurring across the northern boreal and low arctic portion of the Palaearctic region and on the arctic mainland of western North America east to the eastern Northwest Territories and northern Manitoba (Map 2).

*Ilybius fraterculus* LeConte, 1862

*Ilybius fraterculus* LeConte 1862:521. Type specimen: female, in MCZ, labelled: (yellow disc, two sides cut)/Type 6042/*C. fraterculus* Lec./*biguttulus*?. Type locality was given as North Red River.

*Selected reference.* Larson 1975:373–4.

*Description.* Size moderate, 9.3–11.4 mm; body moderately elongate, L/W—1.74–2.01. Measurements on selected population samples are presented in Table 2.

Dorsal surface piceous to black, with a faint cupreous sheen on some specimens.

Table 2. Measurements and ratios for selected population samples of *Ilybius fraterculus* LeConte.

Locality	N	Length L	Maximum width W	L/W	WC/WS
S. Alberta	20	10.22 (0.22)	5.53 (0.12)	1.85 (0.03)	2.42 (0.06)*
		9.76–10.64	5.36–5.76	1.74–1.91	2.32–2.55
S. Manitoba	20	9.94 (0.35)	5.37 (0.18)	1.85 (0.03)	2.60 (0.08)
		9.32–10.51	5.11–5.70	1.80–1.89	2.50–2.87
N. Dakota	17	10.22 (0.27)	5.50 (0.12)	1.86 (0.04)	2.57 (0.10)
		9.77–10.65	5.25–5.70	1.78–1.92	2.43–2.84
Arizona, California, Utah	7	10.51 (0.35)	—	—	2.75 (0.12)
		10.06–11.17			2.54–2.95
California, Modoc Co.	27	10.62 (0.35)	5.62 (0.20)	1.89 (0.04)	2.71 (0.12)
		9.77–11.40	5.25–5.99	1.80–2.01	2.51–2.97

\* From Larson (1975), WS includes width of coxal rim.

Head with frontal spots, anterior margin of clypeus and labrum, rufous: antenna and palpi entirely yellow. Lateral margins of pronotum and elytra broadly reddish: epipleuron rufous. Ventral surface and legs, rufous to piceous.

Pronotum with sculpture consisting of irregular, somewhat rounded meshes over most of disc; however, mediolaterally and sublaterally some meshes are elongated and subparallel. Elytron (Fig. 3) with lines deep, meshes relatively coarse: basally and along suture many meshes narrow and longitudinally stretched with many meshes 3 or more times as long as broad: laterally and apically meshes more rounded in outline and without a definite pattern of orientation: meshes with secondary sculpture obsolete over most of disc and coherent only at extreme apex. Intersections of lines lacking punctures.

Prosternal process elongate, acute apically: lateral bead of moderate width behind procoxae and not evidently inflated, in ventral aspect apex of process more or less evenly narrowed apically from level of termination of lateral bead: in lateral aspect ventral surface of process more or less straight. Metasternum with anteriomedial impression extending posteriorly to level of hind margin of mesocoxae. Metasternal wings broad, WC/WS—2.32 to 2.97.

Metacoxal plate with reticulation distinct but fine, subshiny: striae deep but short, little sinuate and for the most part separate.

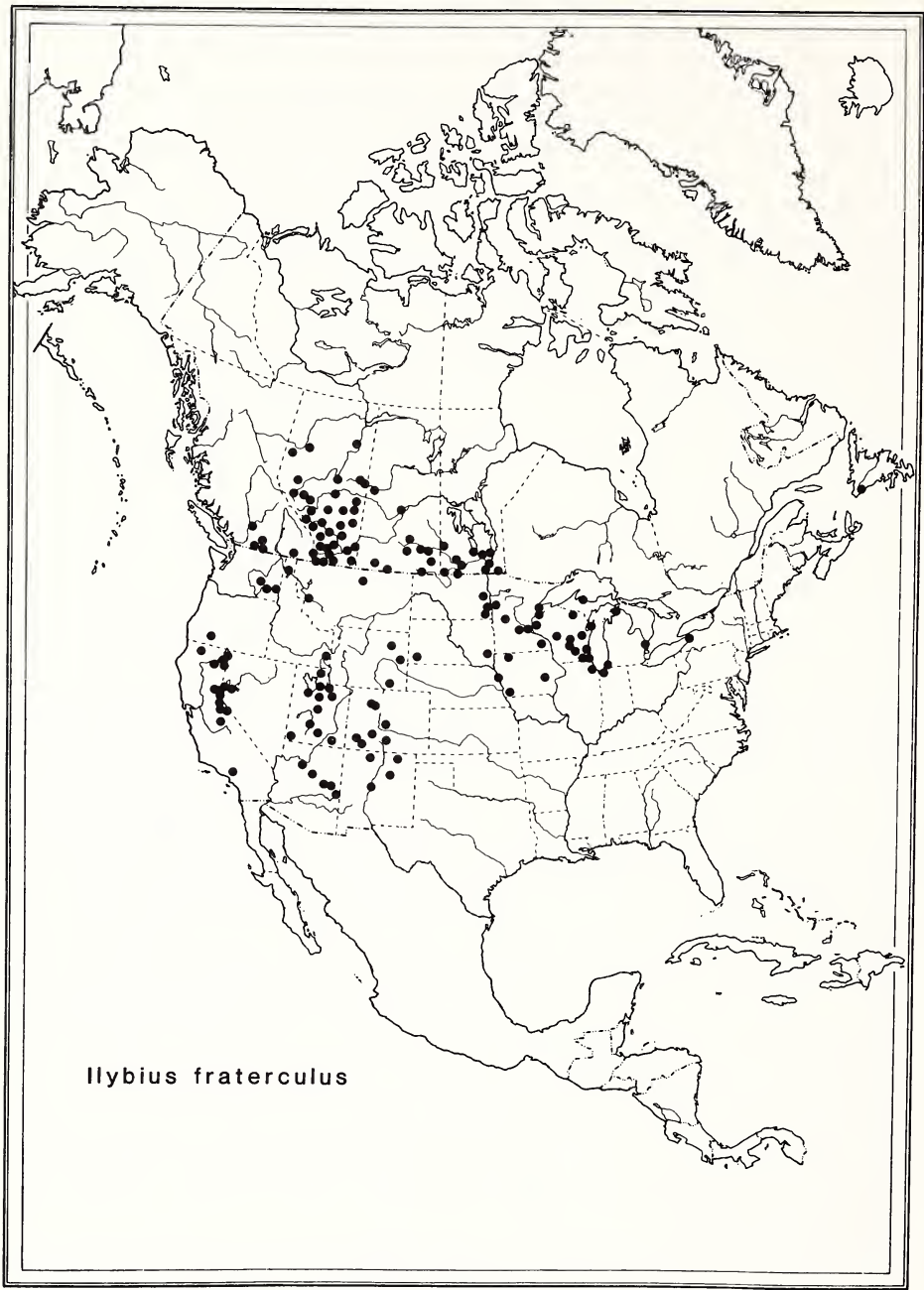
Metafemur finely but distinctly punctate, punctures rounded or a few slightly elongate and forming fine striae. Metafemur with coarse punctation of ventral face restricted to basal third, distal two thirds sparsely and finely punctate. Metatarsomere 1 lacking ventrolateral setae.

MALE: Posterior protarsal claw slightly shorter and narrower than anterior, sinuate ventrally with a shallow ventral basal emargination (Fig. 33). Metatarsus with dorsal claw arcuate apically (Fig. 47). Sternum 6 (Fig. 15) unmodified, lacking rugae and median keel, lateral bead obsolete or faintly traceable medially. Subgenital plate broad apically, subtruncate or shallowly emarginate apically; it and lateral sclerites strigate. Paramere with inner face lacking sucker hairs but with patches of stiff setae near medial shoulder and at base of apical piece: inner basal face broadly sclerotized, lateral face with sclerotized area narrow, shoulder very prominent. Aedeagus with apex bent in a short but distinct hook.

FEMALE: Metatibia and lateral margin of metatarsomeres lacking natatorial setae. Sternum 6 (Fig. 26) with a deep V-shaped posteriomedial emargination: sides of emargination little pinched, lateral angles obtuse but prominent and relatively narrowly rounded, completely margined.

*Variation.* Specimens from the southern portion of the range (Arizona, Utah and California) tend to be slightly larger and have a larger WC/WS ratio than specimens from the northern Great Plains, but there is considerable overlap in the range of values between these populations (Table 2). No other characters have been noted as varying geographically.

*Nomenclatural notes.* The female type has relatively narrow metasternal wings for a specimen of this species (WC/WS—2.92) but it does fall within the observed range. I have assigned it to this species rather than *I. biguttulus* because of its large size, somewhat stretched elytral meshes (although this is not strongly developed), short, more or less isolated striae of the metacoxa, and the relatively deeply emarginate sternum 6.



Map 3. Collection localities for *Ilybius fraterculus*.

*Classification notes.* The parameres have a well developed subapical shoulder but unlike all other species with parameres of this configuration, sucker setae are absent from the mesal face. A group of stout setae are present mesally near the shoulder and they may represent modified sucker setae or be derived from normal vestiture which has become stouter in localized areas. Because of similarity in general paramere form with species with sucker setae, I interpret their absence as loss and not as a plesiotypic state. The absence from males of both rugae on sternum 6 and beading of the metatarsomeres is shared with members of the *I. biguttulus* group as is the reduced metafemoral punctation and the tendency of meshes of the primary elytral sculpture to become longitudinally stretched.

*Ecology.* This species occurs primarily in grassland ponds, usually where the water is sunwarmed but where emergent vegetation is abundant. Larson (1985) noted that of the western species of *Ilybius* this is the most adapted to warm, temporary ponds. Gordon and Post (1965) found this species to be attracted to ultraviolet light in large numbers in North Dakota.

*Distribution.* Collection records extend across the continent at mid latitudes, but the species is common only from the western Great Lakes area and west (Map 3). The single record from Newfoundland is most unexpected and probably represents a vagrant as the species is known to fly readily.

*Ilybius biguttulus* (Germar, 1824)

*Dytiscus biguttulus* Germar 1824:29. Type are: North America (type not seen, type repository not located).

*Ilybius laramaeus* LeConte 1859a:4. Lectotype (here designated), male in MCZ labelled: green disc/Type 6073/C. *laramaeus* LeC. **NEW SYNONYMY** (see Nomenclatural Notes).

*Selected references.* Sharp 1882:558; Leng 1920:80; Fall 1927:283, Wallis 1939:197–8.

*Description.* Size moderate, 8.4 to 11.4 mm, body relatively broadly oval, L/W—1.77 to 1.98. Measurements for selected population samples are given in Table 3.

Color dorsally piceous to black except anterior margin of head, frontal spots and lateral margins of pronotum and elytra reddish to piceous: antenna and palpi yellow to light red, without apical infuscation; legs and epipleuron reddish.

Elytron with meshes of sculpture of small to moderate size and irregular shape (Fig. 4), some males and most females with meshes on basosutural portion of disc somewhat longitudinally stretched but generally length of longest meshes not more than 3 times their width (on some specimens a few meshes 4 or 5× as long as wide have been observed); secondary reticulation effaced or faint basally, evident on apical third to half. Intersections of lines not punctate.

Prosternal process elongate, narrow and acuminate apically: process with lateral bead relatively broad between and behind procoxae; in ventral aspect apex of process abruptly narrowed at level of termination of broadened portion of lateral bead; process in lateral aspect with ventral margin more or less straight or slightly convex. Metasternal impression extending beyond level of hind margin of mesocoxal cavities. Metasternal wings broad, WC/WS—2.55 to 3.32.

Metacoxal plates with striae well impressed, dense, elongate and with various



Table 3. Measurements and ratios for selection population samples of *Ilybius biguttulus* Germar.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Newfoundland, pooled	27	10.12 (0.46)	5.50 (0.27)	1.84 (0.05)	2.87 (0.11)
		9.18–11.40	5.03–5.99	1.77–1.94	2.64–3.06
Nova Scotia, Sable I.	10	9.35 (0.26)	5.13 (0.13)	1.82 (0.03)	3.00 (0.13)
		9.03–9.77	4.88–5.33	1.77–1.86	2.77–3.24
Quebec, Kazubazua	20	9.60 (0.30)	5.14 (0.18)	1.87 (0.03)	2.88 (0.12)
		8.88–10.06	4.74–5.48	1.81–1.94	2.55–3.08
Maryland, Baltimore	20	9.40 (0.39)	5.10 (0.21)	1.84 (0.03)	2.92 (0.10)
		8.43–10.06	4.59–5.48	1.79–1.91	2.76–3.12
Eastern Kansas	19	9.99 (0.25)	5.48 (0.10)	1.83 (0.03)	2.95 (0.11)
		9.62–10.51	5.33–5.62	1.78–1.88	2.76–3.14
Wyoming, pooled	14	10.29 (0.37)	5.44 (0.21)	1.89 (0.21)	2.89 (0.17)
		9.47–10.73	5.03–5.70	1.78–1.98	2.70–3.28
Colorado, Trinidad	15	9.87 (0.28)	5.35 (0.16)	1.85 (0.03)	3.11 (0.10)
		9.47–10.51	5.11–5.70	1.81–1.93	2.93–3.29
Pooled Colorado, New Mexico, Utah	10	10.13 (0.43)	5.49 (0.24)	1.85 (0.03)	3.04 (0.04)
		9.47–10.95	5.10–5.92	1.81–1.92	2.80–3.32

degrees of interconnection: transverse rugae shallow but evident. Metacoxal lines evenly diverging anteriorly, not attaining metasternal suture.

Metafemur very finely punctate, without elongated punctures or striae. Metatibia with ventral surface finely and sparsely punctate medially except for coarse punctures on basal third and along hind margin: longer metatibial spur slightly longer than metatarsomere 1. Metatarsomere 1 lacking mediiodorsal and ventrolateral setae.

MALE: Posterior protarsal claw slightly shorter, narrower and more strongly sinuate ventrally than anterior: both claws with a ventrobasal impression, best developed on posterior claw (Fig. 34). Metacoxae with a small longitudinal keel on posterior region of medial line. Metatarsomeres lacking externodorsal bead: dorsal metatarsal claw tapered and shortly arcuate at apex (Fig. 48). Sternum 6 (Fig. 16) smooth or with a few shallow longitudinal rugae along posterior margin, setiferous punctures evident: a short but distinct posteriomedial longitudinal keel present: lateral bead of sternum obsolete medially near keel. Subgenital plate broad apically with a shallow medial emargination, it and lateral plates with coarse longitudinal striae. Male genitalia (Fig. 62) with paramere bearing sucker hairs on ventral face, aedeagus simple, subequal in length to paramere.

FEMALE: Metatibia with inner margin and metatarsomeres with outer margin lacking natatorial setae. Sternum 6 with posteriomedial emargination of moderate size, lateral angles broadly obtuse and rounded, lateral bead disappearing on angle and internally replaced by a dense marginal array of small punctures: in posterior aspect sides of emargination not or only slightly pinched and middle only slightly raised as a knob.

Variation. This species varies geographically in elytral sculpture, size, relative width, and in the WC/WS ratio. However, the amount of variation is slight with a

great deal of overlap in character states, even between widely separated populations. No pattern of concordance in variation in two or more characters was observed, therefore there are no grounds for recognizing infraspecific groupings of populations.

The largest specimens were from the extremes of the range, Newfoundland and the western Great Plains and Rocky Mountain States. Specimens from Wyoming are on average slightly narrower than specimens from most other populations, but the difference is not statistically significant. The range in values for WC/WS is as great between many adjacent populations as it is between populations from extremes of the range.

A generally useful character for recognizing female specimens of *I. biguttulus* is the shape of the primary meshes of the elytral sculpture. Meshes on the basomedial portion of the elytra of most specimens are short and only slightly elongated while on similar species, namely *I. fraterculus*, *I. incarinatus* and *I. confusus*, at least some meshes are very elongate. However, longitudinally stretched meshes do occur on some female specimens of *I. biguttulus*. This condition was observed among many specimens from northern Quebec, but it also appears on a few specimens from all parts of the range making this character somewhat unreliable for identification purposes, especially when only single specimens are available.

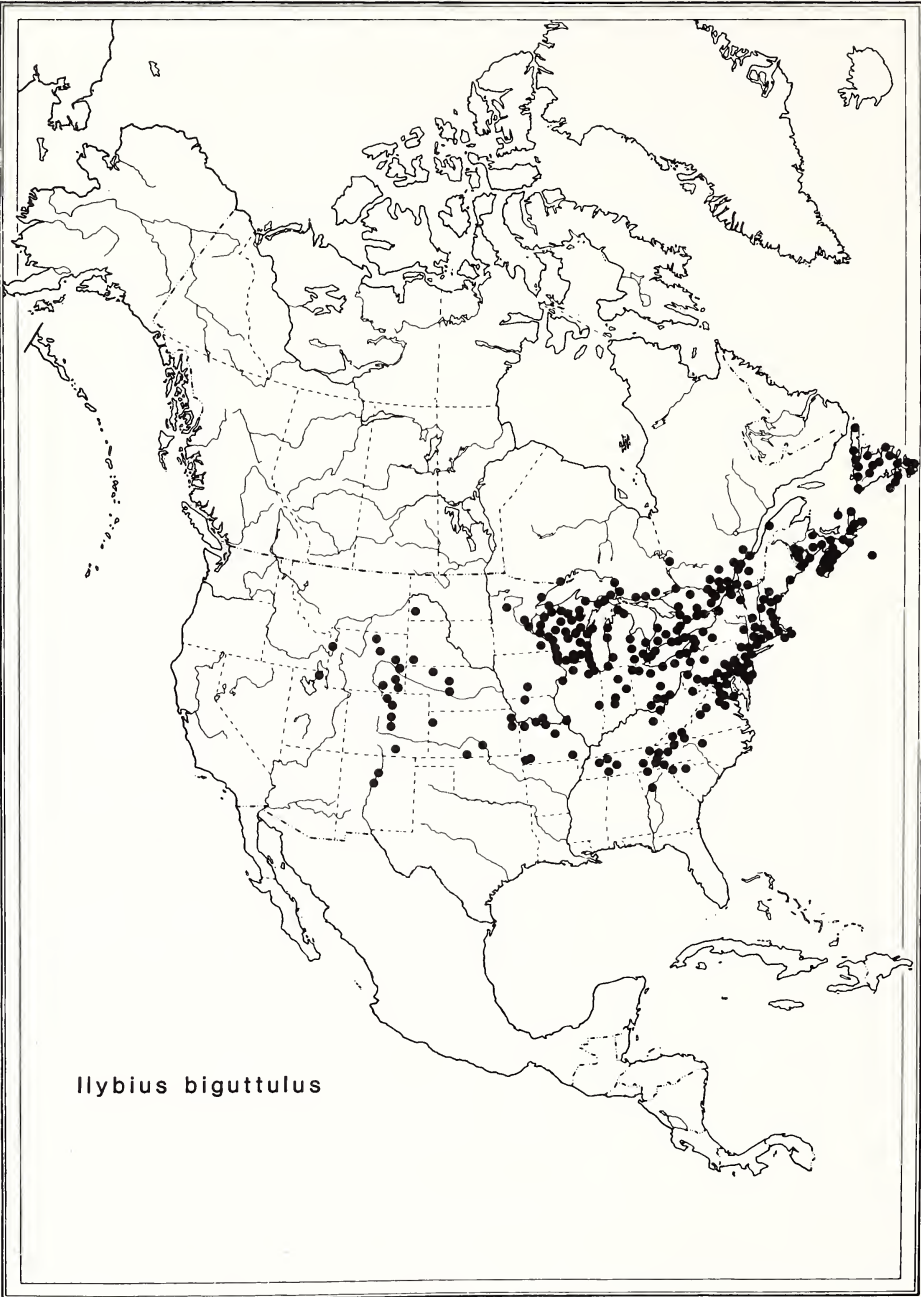
*Nomenclatural notes.* I have not seen the type specimen of *I. biguttulus* (Germar). However, my concept of the species is consistent with that of the LeConte collection, Crotch (1873), Fall (1927) and Wallis (1939).

The validity of the name *I. laramaeus* LeConte was doubted by Fall (1927), but Fall apparently vacillated in his recognition of the species (Wallis, 1939). Wallis (1939) resurrected *I. laramaeus* relying primarily on its narrower form and larger size (in contrast Fall (1927) noted the length of *I. laramaeus* was less than that of *I. biguttulus*) for its separation from *I. biguttulus*, and also providing a number of other minor differences in male pro- and metatarsal claws, and shape of sternum 6 of both sexes. Measurements do not substantiate the size and shape differences (see above and Table 3), nor am I able to support recognition of *I. laramaeus* on other characters; thus I agree with Fall's suggested synonymy.

LeConte (1859b:509) and Fall (1927) both considered *Colymbetes fenestralis* Say (1823:95–96) to be a senior synonym of *I. biguttulus* Germar. This cannot be demonstrated conclusively as Say's types are lost. Say's description offers several important clues as to the identity of his species, namely:

- "antennae and palpi piceous"—The antennae and palpi are not piceous in *I. biguttulus*.
- "sternum acutely carinated"—The acutely carinated sternum may refer to the presence of a carina on abdominal sternum 6 of the male but it is more likely a reference to the shape of the prosternum which Say referred to as the sternum in descriptions of other species in the same paper.
- "It delights in mirey forest springs"—*I. biguttulus* does occur among emergent vegetation in forest springs but the description suggests cold water and peaty habitats, a more usual habitat for *I. angustior* or *I. picipes*.

On the whole, the name probably refers to the species, *I. picipes* Kirby and is senior to *picipes* Kirby. However, because of the tenuous evidence I consider *I. fenestralis* a nomen dubium.



Map 4. Collection localities for *Ilybius biguttulus*.

Table 4. Measurements and ratios for selected population samples of *Ilybius ignarus* LeConte.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Ontario & Quebec	14	8.58 (0.33)	4.40 (0.18)	1.95 (0.06)	3.01 (0.10)
		7.80–9.03	4.14–4.67	1.89–2.07	2.85–3.24
Michigan	12	8.55 (0.36)	4.43 (0.20)	1.93 (0.03)	3.07 (0.08)
		7.84–9.03	4.07–4.66	1.90–1.98	2.97–3.23

*Classification notes.* The male genitalia, including aedeagal and paramere features, are similar among *I. biguttulus*, *I. ignarus*, *I. oblitus*, *I. confusus* and *I. incarinatus*. Other characters shared by these species include: reduced punctation of the metatibia, lack of bead on dorsolateral margins of male metatarsomeres, lack of rugae on male sternum 6, and relatively shallowly emarginate female sternum 6. *I. oblitus* is distinctive due to the very narrow metasternal wing, deeply impressed primary sculpture of the elytron, and short prosternal process. *I. confusus* and *I. incarinatus* are characterized by elongate meshes of the primary elytral sculpture and lack of a carina on male sternum 6. *I. biguttulus* and *I. ignarus* are very similar but *I. biguttulus* is larger, broader, with coarser elytral sculpture, metacoxal plates with striae better developed and male sternum 6 with carina shorter. The overall close similarity of *I. biguttulus* and *I. ignarus* suggests these are sister species which in turn have a common ancestor with the *I. confusus*-*I. incarinatus* ancestor.

*Ecology.* This species occurs in small lentic habitats, where the water is usually sunwarmed and the vegetation is dense. In Newfoundland, where the *Ilybius* fauna is rich (7 species known), this species is found in the warmest, most nutrient-rich habitats occupied by any of the species. I have seen many records of flight between 30 May and 26 July, as well as single records for 20 August and 1 September.

*Distribution.* *Ilybius biguttulus* has a wide distribution in eastern north America, from the southern boreal zone of Newfoundland and Quebec, south to northern Georgia. It is also found in the Rocky Mountain states, from Wyoming to New Mexico and Utah, as well as sparingly across the south-central Great Plains (Map 4).

### *Ilybius ignarus* (LeConte, 1862)

*Colymbetes ignarus* LeConte 1862:521. Lectotype.—here selected, male in MCZ labelled as follows: pale blue disc/"type 6071"/"C. ignarus LeC." Type locality not stated but pale blue disc is LeConte's color code for Lake Superior, Canada, and north.

*Selected references.* Sharp 1882:554; Leng 1920:80; Fall 1927:283; Wallis 1939:197.

*Description.* This is a small (length 7.8 to 9.1 mm), elongate (L/W—1.89 to 2.07), black species. Measurements for two population samples are given in Table 4.

Color of body black dorsally except frontal spots, anterior margin of clypeus and lateral margins of pronotum and elytron dark rufous to piceous; antenna and palpi entirely pale, without infuscation; venter mainly black with epipleuron and legs dark reddish.

Elytron (Fig. 5) with sculpture consisting of small meshes of irregular size and



shape which either show no tendency of longitudinal stretching, or basosuturally a few meshes slightly elongated: secondary sculpture obsolete basally but evident apically: intersections of lines without punctures.

Prosternal process elongate, apically acuminate: lateral bead broadened between procoxae; in ventral aspect process evidently constricted at level of termination of thickened portion of lateral bead then more or less evenly narrowed towards apex. Metasternal impression well developed and extending posteriorly to level of hind margin of mesocoxal cavities. Metasternal wings somewhat narrower than in *I. biguttulus*, WC/WS—2.85 to 3.24.

Metacoxal plates with microreticulation relatively lightly impressed, surface shiny: striae sparse, shallow, short and more or less isolated; sparse punctation distinct. Metacoxal lines not reaching metasternal suture.

Metafemur with ventral face finely punctate, nonstrigate. Metatibia with ventral face finely and sparsely punctate except for coarse punctures at base and along hind margin. Longer metatibial spur slightly longer than metatarsomere 1. Metatarsomere 1 lacking dorsal and ventral coarse spines.

MALE: Anterior and posterior protarsal claws (Fig. 35) similar in shape, shallowly but evidently sinuate ventrally, the posterior claw most distinctly so. Metacoxae with a small longitudinal keel on posterior portion of medial line. Metatarsomeres lacking bead on outer dorsal margin: dorsal metatarsal claw (Fig. 49) slender, its apex narrowly rounded. Sternum 6 (Fig. 17) with posterior margin smooth or faintly rugose, setiferous punctures evident; with a low medial longitudinal keel which on most specimens is at least faintly traceable along midline of posterior half of sternite: lateral bead well developed and continuous along hind margin to medial keel. Subgenital plate with apex broad and shallowly emarginate, it and lateral plates coarsely strigate. Male genitalia (Fig. 63) with paramere bearing sucker hairs of irregular length along inner face: aedeagus simple.

FEMALE: Metatibia with inner margin and metatarsomeres along outer margin lacking natatorial setae. Sternum 6 with apical emargination shallow, lateral margins of emargination appearing pinched in posterior aspect so that sternum at middle is produced as a short knob or ridge: lateral bead complete around lateral angles of emargination.

*Variation.* No geographical or appreciable intrapopulation variation has been noted.

*Nomenclatural notes.* The LeConte Collection (MCZ) contains 9 specimens under the name *I. ignarus*. In addition to the lectotype, specimens are from Escabanba, Michigan (2); White Fish Point, Lake Superior (5); and a female specimen of the *I. angustior* complex bearing a pale blue disc. The lectotype bears the label "C. ignarus LeC.," presumably in LeConte's handwriting. It is teneral and brown, not black, in color.

*Classification notes.* *Ilybius ignarus* is similar to *I. biguttulus*, differing mainly in size, shape, and sculpture of elytra and metacoxal plates (see notes under *I. biguttulus*).

*Ecology.* Adults have been collected from peatland pools. Mr. C. Chantal (in litt.) has reported specimens collected in bottle traps situated in open water areas of acidic peat bogs. Specimens have been collected at light between 29 June and 25 July, and 14 September.

*Distribution.* The distribution is rather limited, with collection records occurring primarily in the northern Appalachian region and adjacent boreal areas (Map 2).

Table 5. Measurements and ratios for selected population samples of *Ilybius incarinatus* Zimmermann.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Ontario & Quebec	7	9.29 (0.39)	5.21 (0.19)	1.78 (0.05)	3.09 (0.13)
		8.73–9.92	5.03–5.55	1.73–1.86	2.84–3.22
Massachusetts, pooled	37	9.51 (0.30)	5.27 (0.17)	1.80 (0.05)	3.08 (0.12)
		8.88–10.14	4.88–5.70	1.70–1.95	2.78–3.39
New York and Connecticut, pooled	6	9.60 (0.17)	5.41 (0.06)	1.77 (0.03)	3.20 (0.11)
		9.40–9.77	5.33–5.48	1.73–1.81	3.05–3.29
Illinois, pooled	15	9.24 (0.34)	5.12 (0.18)	1.81 (0.03)	3.07 (0.15)
		8.58–9.84	4.81–5.48	1.75–1.86	2.79–3.31

*Ilybius incarinatus* Zimmermann, 1928

*Ilybius incarinatus* Zimmermann 1928:181–2. Lectotype (here designated)—male in ZSM, labelled—“Nord-Amerique”/“♂”/blue disc “type”/Lectotype, *Ilybius incarinatus* Zimmermann, des. D. Larson.” Type locality given as Glauco, Illinois.

*Selected reference.* Wallis 1939:198.

*Description.* Size moderate (L—8.5 to 10.1 mm), body relatively broad (L/W—1.70 to 1.95). Measurements and ratios for selected population samples are presented in Table 5 and Figure 73. This species is very similar to *I. confusus* but is smaller and darker in color.

Head red, palest anteriorly and darkened between eyes and along posterior margin: antenna and palpi entirely pale. Pronotum piceous medially, lateral margins broadly reddish. Elytra piceous to black medially, lateral margins lateral of submedial spot, reddish, disc either gradually darkened mesad or some specimens with transition to dark color of disc relatively abrupt: epipleuron red. Ventral surface and legs red to piceous.

Elytron basosuturally (Fig. 6) with many narrow, elongate, parallel meshes interspersed with shorter smaller meshes, many meshes 5× or more as long as wide: laterally and posteriorly meshes less evidently stretched and more rounded or irregular in shape. Meshes smaller and more regular than in *I. confusus*, with fewer laterally confluent meshes.

Prosternal process elongate and acuminate: marginal bead somewhat inflated between procoxae: in ventral aspect apex relatively abruptly constricted distad of broadened portion of lateral bead; in lateral aspect apical portion deflected dorsad and somewhat out of plane of basal portion of process, or some specimens with ventral margin broadly arched. Metasternum with anteriomedial impression reaching level of hind margin of mesocoxal cavities. Metasternal wings moderately broad, WC/WS—2.7 to 3.5.

Metacoxal plates with striae fine, elongate, somewhat sinuate and variously branched or interconnected, especially posteriorly; striae longer and better developed than on *I. confusus*. Metacoxal lines not attaining metasternal suture.

Metafemur finely punctate, with a few very fine striae present posteriomedially. Metatibia with ventral face finely punctate except for coarse punctures at base and

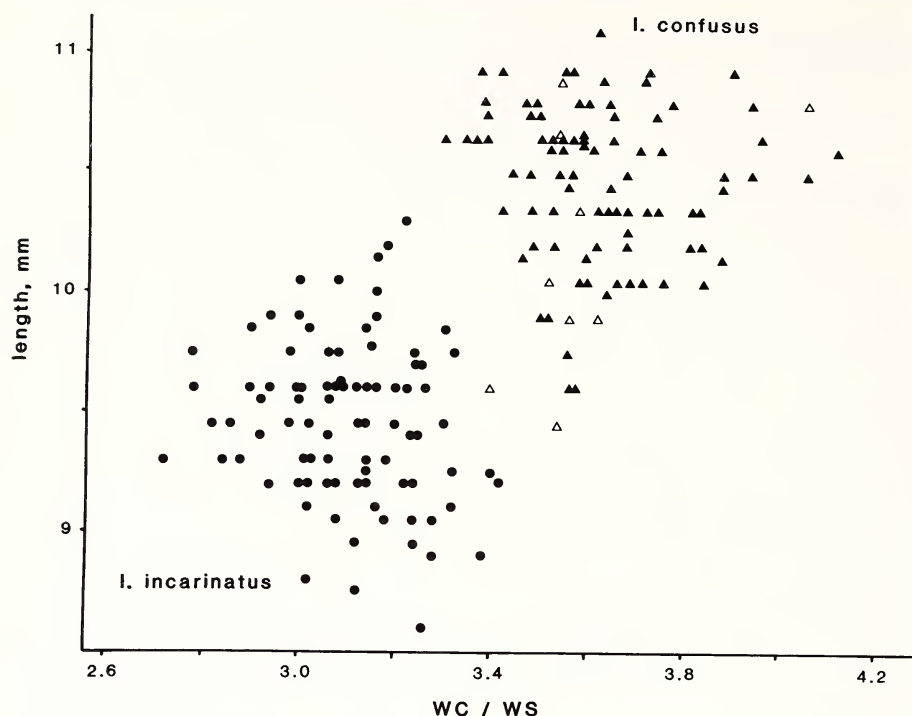


Fig. 73. Scatter diagram of length versus WS/WC for specimens of *I. confusus* (closed triangles) and *I. incarinatus* (closed circles). Open triangles represent specimens from Washington, D.C., of which the two specimens intermediate between *I. confusus* and *I. incarinatus* are best assigned to *I. incarinatus*, the remainder belong to *I. confusus*.

along hind margin. Longer metatibial spur longer than metatarsomere 1. Metatarsomere 1 lacking dorsal and ventral longitudinal spines.

MALE: Protarsal claws (Fig. 36) similar in shape but posterior claw slightly shorter than anterior, ventrally each claw slightly sinuate and emarginate basally. Metacoxae with a small keel on posterior portion of medial line. Metatarsomeres lacking dorsoexternal bead. Dorsal metatarsal claw (Fig. 50) narrow, subparallel and broadly rounded to ventroapical point. Sternum 6 unmodified, broadly rounded or slightly truncate apically, completely margined laterally; surface lacking rugae and posteromedial keel. Subgenital plate broad apically, it and lateral plates strigate. Genitalia (Fig. 64) with paramere and aedeagus of *biguttulus* type.

FEMALE: Metatibia with internal margin and metatarsomeres with outer margin lacking natatorial setae. Sternum 6 with apical emargination shallow, in posterior aspect sides slightly compressed with middle produced as a short rounded knob; marginal bead complete except at crest of medial knob.

*Variation.* See Classification Notes.

*Nomenclatural notes.* A. Zimmermann described this species from two specimens, a male and a female. He referred to the specimens as type and cotype but did not



Map 5. Collection localities for *Ilybius incarinatus* and *I. churchillensis*.



distinguish which was type. Each specimen bears a blue disc with type written on it. I selected the male specimen as the lectotype.

*Classification notes.* Specimens of *I. incarinatus* are very similar to those of *I. confusus*, differing mainly quantitatively in character states rather than through possession of any unique feature. For example, the aedeagus of *I. incarinatus* is shorter than that of *I. confusus* but aedeagal length is correlated with, and bears the same relation to, body length in both species ( $r = 0.93$ ) indicating that specimens of *I. confusus* are larger than those of *I. incarinatus*. The two best characters for discriminating between the species are body length and the ratio WC/WS (Fig. 73). Specimens segregate into two well defined groups with no geographical pattern of variation in either character except population samples from Washington, D.C., and New Jersey contain a few specimens that are difficult to place. These intermediate specimens appear to be large specimens of *I. incarinatus* as definite specimens of *I. confusus* from the area fall well within the range of measurements of *I. confusus*. The shape of the prosternal process of these intermediate specimens is similar to that of *I. incarinatus*, supporting their assignment to this species.

Because the two forms occupy approximately the same geographical area and because almost all specimens fall clearly into one group or the other, recognition of two species seems well justified. It is possible that hybridization may occur in Washington, D.C., and southern New Jersey. In all other regions the two species are distinct. There is no evidence of geographical variation nor do specimens of either species from regions from which only one species is known show any different degree of variation than those from areas where both occur sympatrically.

*Ecology.* Nothing is known about the habitat of this species. Specimens have been collected at light from June 12 to 23 in Massachusetts, Quebec and Washington, D.C.

*Distribution.* This species occurs in the region around the Great Lakes and south to Washington, D.C., and Tennessee (Map 5).

*Ilybius confusus* Aubé, 1838

*Ilybius confusus* Aubé 1838:280. Type area: United States, type not located.

*Ilybius denikei* Wallis 1933:271. Holotype: male in CNC, CNC type no. 5650, type locality-Ingolf, Ontario. **NEW SYNONYMY.**

*Selected references.* Sharp 1882:559; Leng 1920:80; Fall 1927:284-5; Wallis 1939:199.

*Description.* This is a moderately large (length 9.7 to 11.0 mm), broad (L/W—1.73 to 1.91) species. Measurements and ratios for selected population samples are presented in Table 6.

Color various, body rufous to piceous dorsally with lateral margins broadly paler reddish: red lateral margins gradually darkened mesad on disc or some specimens with body laterad of sublateral elytral vittae abruptly paler: elytron with subapical vitta present as a small triangular or crescentic spot, sublateral vitta various in size ranging from a small oval spot subequal in size to subapical vitta to a long line about half length of elytron. Antenna and palpi pale, without infuscation. Ventral surface and legs red to piceous.

Elytron with sculpture various, basosuturally (Fig. 7) most specimens with some

Table 6. Measurements and ratios for selected population samples of *Ilybius confusus* Aubé.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Ontario, Ingolf	20	10.35 (0.31)	5.80 (0.14)	1.78 (0.03)	3.67 (0.14)
		9.77–10.95	5.55–6.07	1.73–1.81	3.41–4.07
Massachusetts, pooled	28	10.57 (0.23)	5.87 (0.11)	1.80 (0.05)	3.55 (0.12)
		10.06–10.95	5.62–6.07	1.68–1.91	3.37–3.84
New York, pooled	12	10.67 (0.29)	5.91 (0.18)	1.80 (0.04)	3.57 (0.18)
		9.92–10.95	5.48–6.07	1.75–1.86	3.33–3.97
Washington, D.C.*	10	10.13 (0.52)	5.62 (0.31)	1.80 (0.02)	3.59 (0.18)
		9.47–10.88	5.18–6.07	1.78–1.86	3.41–4.06
New Jersey, pooled	5	10.30 (0.60)	5.80 (0.24)	1.77 (0.05)	3.46 (0.20)
		9.47–10.95	5.48–6.07	1.73–1.85	3.14–3.68

\* Sample contains some specimens intermediate between *I. confusus* and *I. incarinatus* (see Fig. 73).

meshes of primary sculpture longitudinally stretched and with a few meshes  $5\times$  or more as long as wide: meshes coarser than in *I. incarinatus*, not so regular in form with more lateral fusion of adjacent meshes to give many meshes of very irregular shape on basosutural portion of disc (a few specimens have been seen in which the sculpture is similar to that of *I. biguttulus* with meshes small, rounded and not especially stretched or laterally fused).

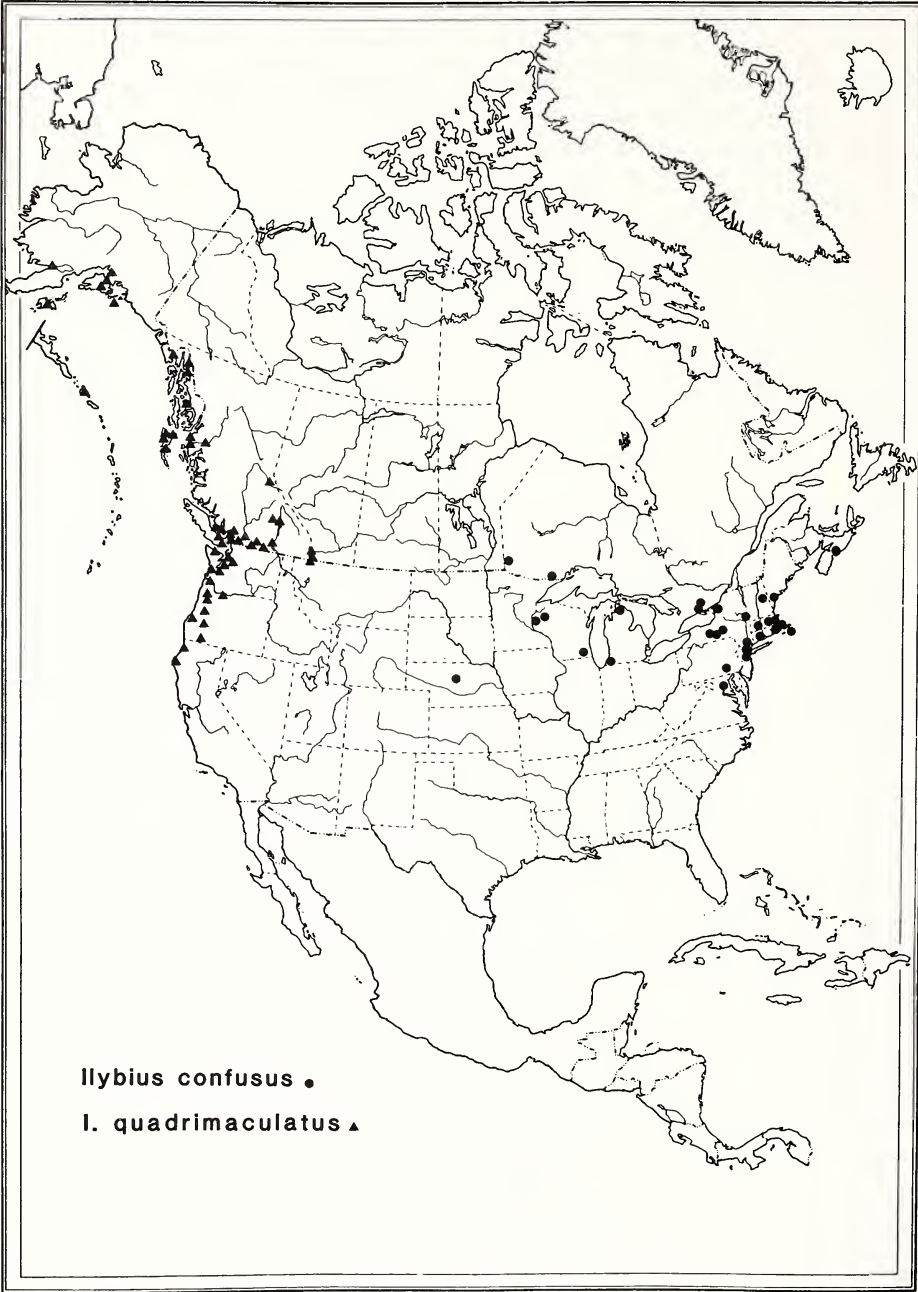
Prosternal process elongate and acuminate apically: lateral bead evidently broadened between procoxae; in ventral aspect apex more or less evenly tapered distally from level of termination of broadened portion of lateral bead, apex more evenly narrowed than in *I. incarinatus*: in lateral aspect, ventral margin straight or only slightly convex. Metasternal impression extended posteriorly to level of hind margin of mesocoxal cavities. Metasternal wing narrow, WC/WS—3.3 to 4.1.

Metacoxal plate with dense subparallel striae but striae short and more or less separate. Metacoxal lines not reaching metasternal suture.

Metafemur finely and sparsely punctate, without or with only very faint striae near posterior margin. Metatibia with ventral face finely punctate medially and distally or with a sparse row of slightly larger punctures along mid longitudinal region; coarser punctures present at base and paralleling inner margin. Longer metatibial spur longer than metatarsomere 1. Metatarsomere 1 lacking ventrolateral coarse setae.

MALE: Protarsal claws (Fig. 37) each with a small ventrobasal emargination. Medial metacoxal line with a faint keel near posterior end. Metatarsomeres lacking dorsolateral bead. Metatarsal claws (Fig. 51) with dorsal claw slightly arcuate, narrowing gradually towards apex. Sternum 6 (Fig. 19) with apex more or less truncate, marginal bead complete: ventral surface smooth and without longitudinal rugae or posteromedial keel. Subgenital plate with apex broad, emarginate medially, it and lateral plates longitudinally strigate. Male genitalia (Fig. 65) with parameres and aedeagus of *biguttulus* type, sucker hairs present on medial face of paramere.

FEMALE: Metatibia along internal margin and metatarsomeres externally lacking natatorial setae. Sternum 6 (Fig. 27) shallowly emarginate apically, lateral angles of emargination very broadly rounded and with a complete marginal bead: in posterior



Map 6. Collection localities for *Ilybius confusus* and *I. quadrimaculatus*.

aspect sides of emargination compressed and middle of emargination acutely produced.

*Variation.* Specimens of *I. confusus* vary somewhat in size and in the width of the metasternal wing, but specimens are for the most part separated from those of *I. incarinatus* by distinct gaps in these measurements (Fig. 73, see discussion under *I. incarinatus*). This variation is mainly intrapopulation.

Specimens from western Ontario are conspicuously paler than those from other localities. They have the heads and sides of the body broadly reddish and the sub-lateral vitta of the elytron is broad and elongate (one quarter to half the length of the elytron). Wallis described this pale form as *I. denikei*. As I have not discovered any characters other than color for separating *I. denikei* from other specimens of *I. confusus*, I consider it a junior synonym of *I. confusus*. Specimens of *I. subaeneus* from certain localities in western Ontario are also exceptionally pale so that there seems to be some environmental factor in the area promoting the development of paler color in certain species of *Ilybius*. Wallis stated that the type series of *I. denikei* was collected on a sandy lake shore. Often water beetles occurring in exposed sites or on pale mineral substrates are paler or more strongly patterned than usual (Young, 1960), and this may be the explanation for the unusual color of the *I. denikei* specimens.

*Nomenclatural notes.* Wallis (1933) had doubts about the validity of his species, *I. denikei*, but decided that color characters were constant enough to justify separating the western Ontario specimens from other specimens of *I. confusus*. I recognize the paler color of specimens of *I. denikei* but because the color characters are not supported by any other differences, I regard *I. denikei* as a junior synonym of *I. confusus*.

*Classification notes.* *Ilybius confusus* is the sister species of *I. incarinatus* which it closely resembles in almost all characters including form of the male genitalia. These species are in turn similar to *I. biguttulus* and I include them together in the same group (see discussion under *I. biguttulus*).

*Ecology.* Wallis (1933:272) has given the only description of the habitat. The type series of *I. denikei* was taken from along the shore of Long Pine Lake near Ingolf, Ontario. The beetles occurred among plant debris in shallow water along a sandy lake shore near where a small stream entered the lake from a swamp. I have seen a record for flight on 7 July.

*Distribution.* The range extends along the Atlantic coast from Nova Scotia to Washington, D.C., and westward to the edge of the Great Plains (Map 6). A single specimen from central Nebraska is unexpected but there is no reason to doubt the record.

### *Ilybius oblitus* Sharp, 1882

*Ilybius oblitus* Sharp 1882:560. Lectotype—here designated, male in BMNH, labelled as follows: specimen pinned to a card labelled “♂ Am. bor. 856”/red rimmed disc “type”/“Sharp Coll. 1905-313”/“Type 856 oblitus Am. bor.”

*Selected references.* Leng 1920:80; Fall 1927:283; Wallis 1939:197; Young 1954:102.

*Description.* This species is of moderate size (length 8.9 to 10.7 mm) and relatively



Table 7. Measurements and ratios for selected population samples of *Ilybius oblitus* Sharp.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Massachusetts, New York, New Jersey	12	9.70 (0.28) 9.18–10.06	5.24 (0.14) 4.96–5.40	1.85 (0.03) 1.78–1.89	5.76 (0.46) 5.17–6.78
Michigan and Ohio	8	9.65 (0.55) 8.95–10.66	5.34 (0.17) 5.11–5.62	1.81 (0.06) 1.74–1.89	5.51 (0.20) 5.25–5.81
Missouri, Winona	20	9.50 (0.29) 9.03–10.06	5.18 (0.17) 4.88–5.48	1.84 (0.04) 1.78–1.91	5.58 (0.31) 5.09–6.32

broadly oval shape (L/W—1.74 to 1.91). Measurements and ratios for specimens from three population samples are given in Table 7.

Color of dorsal surface piceous to black medially, head with anterior margin and frontal spots and lateral margins of pronotum and elytra reddish, grading shortly into darker color of disc. Antenna and palpi entirely pale. Ventral surface of body reddish to piceous.

Elytron (Fig. 8) with sculpture coarse, lines deeply impressed and broad, meshes of irregular size but for most part small and rounded but some slightly stretched longitudinally basomedially and, on some specimens, meshes just posterad of middle slightly transverse. Meshes with evident microreticulation apically but smooth on basal half.

Prosternal process short and broad, medially narrowly rounded and not carinate; metasternal impression in which it is received short, on most specimens not attaining level of hind margin of mesocoxal cavities. Metasternal wing very narrow, WC/WS—5.09 to 6.78.

Metacoxal plate with striae deeply impressed, dense and elongate, and forming more or less continuous subparallel lines across length of plate. Metacoxal lines relatively little diverging, not reaching metasternum.

Metafemur with short oblique striae on ventral face. Metatibia with ventral face finely and sparsely punctate except for coarse punctures at base and along inner margin: longer metatibial spur subequal to or longer than metatarsomere 1: metatarsomere 1 lacking ventrolateral coarse setae.

MALE: Protarsal claws (Fig. 38) sinuate ventrally, posterior claw with a deep ventrobasal emargination. Metacoxae with median line bearing a small longitudinal keel on posterior portion. Metatarsomeres lacking a dorsolateral bead. Dorsal metatarsal claw (Fig. 52) narrowed more or less evenly to arcuate apex. Sternum 6 (Fig. 20) broadly rounded apically, with a complete marginal bead: surface smooth, lacking rugae or with only faint, broad longitudinal impressions posteriolaterally; posterio-medial keel absent but a light low posterio-medial longitudinal swelling or tumid area evident. Subgenital plate broad apically, it and lateral plates strongly strigate. Genitalia (Fig. 66) with paramere with sucker hairs sparse, of unequal lengths: aedeagus simple, with apex obliquely rounded.

FEMALE: Metatibia along internal margin and metatarsomeres along external margin lacking natatorial setae. Sternum 6 with apical emargination narrow and shallow, sternum margined laterally and on angles of emargination: emargination with lateral angles obtuse, sides slightly compressed in posterior aspect and middle produced into a well developed ridge.



Map 7. Collection localities for *Ilybius oblitus*. Triangle represents a state record.

*Variation.* No pattern of geographical variation has been observed.

*Classification notes.* *Ilybius oblitus* shares many characters with *I. biguttulus* but does have some unique features, namely: narrow metasternal wings, short prosternal process, coarse elytral sculpture and an obliquely rounded apex of the aedeagus. Thus, the species is somewhat separated from the other four members of the *I. biguttulus* group. Although male sternum 6 lacks a distinct posteriomedial carina, a faint longitudinal convexity can be discerned on most specimens suggesting either the beginnings of the development of a carina, or the final stages of its loss.

*Ecology.* I collected several specimens from among emergent grasses and rushes at the edge of a flooded borrow pit in southern New Jersey. The water was clear and warm and the bottom composed of sand covered with plant debris. The only flight record is for a specimen collected at light on 23 June 1907, in Washington, D.C.

*Distribution.* The range extends from New York to Virginia and west to Kansas (Map 7). Young (1954) gave a single Florida record but doubted its validity.

*Ilybius angustior* (Gyllenhal, 1808)

*Dytiscus angustior* Gyllenhal 1808:500. Types in Gyllenhal Collection, Dept. of Entomology, University of Uppsala; types revised and male lectotype designated by Persson 1985. Type area: Sweden.

*Ilybius picipes*: auctorum, not Kirby, 1837.

*Selected references.* Larson, 1975; Persson, 1985.

*Description.* This is a small to moderate sized species (length—7.5 to 10.2 mm) of somewhat elongate shape ( $L/W$ —1.81 to 2.03). Measurements on selected population samples are presented in Table 8.

Head black dorsally except frontal spots between eyes and anterior margin reddish: antenna yellow with outer flagellomeres infusate apically (palest specimens with at least apical flagellomere infusate medially); palpi yellow with apical palpomere of each palpus infusate medially on most specimens. Pronotum with disc black, lateral margin narrowly reddish or piceous and evenly darkened onto disc. Elytra of most specimens piceous and not fully black, lateral margins and epipleura reddish: disc may be shiny with a faint metallic sheen or dull. Ventral surface of body piceous to black, legs dark red.

Elytron (Fig. 9) with meshes of sculpture small, laterally rounded but irregular in size and shape; without regular pattern of orientation or stretching and with little tendency of fusion of adjacent meshes. Meshes microreticulate with reticulation shallow and somewhat effaced basally.

Prosternal process of only moderate length, apex acuminate: lateral bead well developed but not especially inflated between procoxae, distinct along lateral margin to apex: process strongly tectiform and sides not noticeably explanate immediately posteriad to procoxae; in ventral aspect shape lanceolate. Metasternum with anteriomedial impression extended posteriorly to level of hind margin of mesocoxal cavities. Metasternal wings broad,  $WC/WS$ —2.04 to 2.82 (Table 8).

Metacoxal plate finely reticulate: striae fine and numerous, irregular with considerable joining and intersection of lines: punctures numerous and situated in striae. Metacoxal lines faintly sinuate, elongate but not reaching metasternum.

Metafemur relatively densely punctate but punctures not elongate or linear. Meta-

Table 8. Measurements and ratios for selected population samples of *Ilybius angustior* Gyll.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Alaska, Nome	18	8.36 (0.24) 7.99–8.88	4.37 (0.15) 4.07–4.66	1.92 (0.04) 1.85–2.01	2.35 (0.13) 2.04–2.61
Y.T., Ogilvie Mts.	16	8.74 (0.19) 8.44–9.18	4.47 (0.08) 4.29–4.59	1.95 (0.04) 1.89–2.03	2.46 (0.12) 2.27–2.69
N.W.T., Reindeer Sta.	40	8.26 (0.29) 7.55–8.88	4.35 (0.14) 4.00–4.81	1.90 (0.04) 1.82–1.97	2.28 (0.11) 2.05–2.66
N.W.T., Aklavik	52	8.45 (0.26) 7.99–9.10	4.36 (0.16) 4.00–4.88	1.94 (0.05) 1.82–2.02	2.27 (0.11) 2.08–2.58
N.W.T., Richards I.	15	8.37 (0.24) 7.77–8.80	4.40 (0.13) 4.07–4.59	1.90 (0.03) 1.84–1.97	2.33 (0.10) 2.20–2.50
N.W.T., Eskimo Pt.	19	8.61 (0.23) 8.21–9.03	4.48 (0.13) 4.29–4.74	1.92 (0.04) 1.82–1.97	2.37 (0.07) 2.26–2.47
N.W.T., Coppermine	44	8.20 (0.22) 7.77–8.58	4.23 (0.11) 4.00–4.44	1.94 (0.03) 1.89–2.04	2.38 (0.13) 2.16–2.68
N.W.T., Ft. Smith	20	8.79 (0.26) 8.44–9.47	4.68 (0.17) 4.29–5.03	1.88 (0.04) 1.81–1.97	2.50 (0.14) 2.27–2.82
Alberta, Manning	20	8.96 (0.30) 8.40–9.44	4.75 (0.17) 4.44–5.04	1.89 (0.03) 1.82–1.93	2.24 (0.11)* 2.10–2.47
Manitoba, Churchill	19	8.66 (0.32) 7.99–9.18	4.52 (0.19) 4.14–4.88	1.92 (0.04) 1.86–2.00	2.48 (0.10) 2.25–2.61
Quebec, Gt Whale R.	16	8.92 (0.29) 8.36–9.47	4.68 (0.13) 4.44–4.88	1.91 (0.03) 1.85–1.97	2.53 (0.10) 2.38–2.73
Quebec, Harrington Hr.	20	8.95 (0.28) 8.44–9.55	4.67 (0.12) 4.44–4.88	1.92 (0.03) 1.85–1.97	2.52 (0.10) 2.30–2.78
Newfoundland, N. Penn. (♂)	20	9.42 (0.29) 8.88–9.84	4.88 (0.16) 4.59–5.11	1.93 (0.03) 1.88–2.00	2.47 (0.10) 2.25–2.61
Newfoundland, Avalon Penn.	20	9.37 (0.39) 8.73–10.21	4.91 (0.18) 4.59–5.33	1.91 (0.04) 1.84–1.97	2.49 (0.13) 2.21–2.72

\* From Larson (1975), WS includes width of coxal rim.

tibia with a series of coarse punctures extending entire length of ventral face, density of punctures various but on average specimens of *I. angustior* have the metatibia more densely and coarsely punctate than do specimens of *I. picipes*. Longer metatibial spur subequal to or slightly shorter than metatarsomere 1. Metatarsomere 1 without dorsomedial setae but with from 1 to several stout spines along ventrolateral margin.

MALE: Protarsus (Fig. 39) with posterior claw narrower and more arcuate than anterior, both straighter than respective claws of *I. picipes*. Metacoxae with a small posteriomedial keel. Metatarsomeres with a dorsolateral bead or ridge. Metatarsal claws (Fig. 53) with dorsal claw blade-like, shallowly emarginate externobasally and evidently broadened medially. Sternum 6 (Fig. 21) with a posteriomedial longitudinal keel, hind surface lateral to keel with strong longitudinal rugae. Subgenital plate broad and truncate apically, broader than that of *I. picipes*, longitudinally strigate laterally; lateral plates longitudinally strigate. Genitalia (Fig. 67) with paramere narrow, with



sucker hairs on mesal face: aedeagus narrow, apex slightly reflexed ventrally and evidently narrowed in lateral aspect.

**FEMALE:** Metafemur along internal margin and metatarsomeres along outer margin lacking natatorial setae. Sternum 6 (Fig. 28) with posteriomedial emargination well developed, its sides not appreciably pinched in posterior aspect: marginal bead complete around lateral angles of emargination. Gonocoxa with dorsal margin more curved at base and apex more abruptly pointed than that of *I. picipes*.

**Variation.** The occurrence of two additional very similar species, *I. picipes* (Kirby) and *I. churchillensis* Wallis, compounds the problem of interpreting patterns of variation in this species because supposed intraspecific variation may be due to misidentification. For example, I confused *I. picipes* with *I. angustior* in the past (Larson, 1975) and am certain that some of my identifications of female specimens are still wrong as I cannot separate the two consistently without association with males. Also, species of this complex show some parallel patterns of variation in regions of sympatry.

The smallest specimens of *I. angustior* are from along the western arctic mainland coast. Specimens from more southerly localities are considerably larger, for example mean length of specimens along a north-south transect are: Reindeer Station, N.W.T.—8.26 mm; Ft. Smith, N.W.T.—8.79 mm; Manning, Alta.—8.96 mm. Specimens of *I. churchillensis* also increase in size from north to south (Reindeer Station, N.W.T.—7.78 mm; Churchill, Man.—8.01 mm). Over the boreal region, the mean size of *I. angustior* specimens is fairly uniform at about 8.8 to 9.0 mm but specimens from the island of Newfoundland are noticeably larger (mean about 9.4 mm). *I. picipes*, which is largely sympatric with *I. angustior* over the boreal region, shows a similar but less pronounced tendency towards larger size on the island of Newfoundland; however, this is influenced by the omission of female specimens from Newfoundland as their identity is uncertain.

The ratio WC/WS varies only slightly, tending to be smaller in the low arctic than in boreal portions of the range, but the differences in population means are slight.

Similarity in the pattern of variation in length and WC/WS between populations of *I. angustior* and *I. churchillensis* can be seen in Figure 74. In spite of the variation, in localities of sympatry the two species can be separated fairly reliably on the basis of these measurements.

Fortunately, the diagnostic characters for the separation of male *I. angustior* from males of *I. picipes*, medially dilated dorsal metatarsal claw, and narrow reflexed apex of aedeagus, while slight, are remarkably constant over the wide holarctic range.

**Nomenclatural notes.** Old World synonymy is given by Zimmermann (1920) and is not repeated here. *I. picipes* (Kirby) is not a synonym of *I. angustior* and many holarctic records of *I. angustior* are probably based on misidentified specimens of *I. picipes*, some of my previous records certainly are (Larson, 1975; Larson and Colbo, 1983).

**Classification notes.** Persson (1985) has shown that most previous authors have defined *I. angustior* too broadly and that over much of the Holarctic distribution two sympatric sibling species occur (see discussion under *I. picipes* (Kirby)). In addition, in the arctic mainland of North America, west of Hudson Bay, *I. angustior* co-occurs with or is replaced by another very similar species, *I. churchillensis* Wallis.

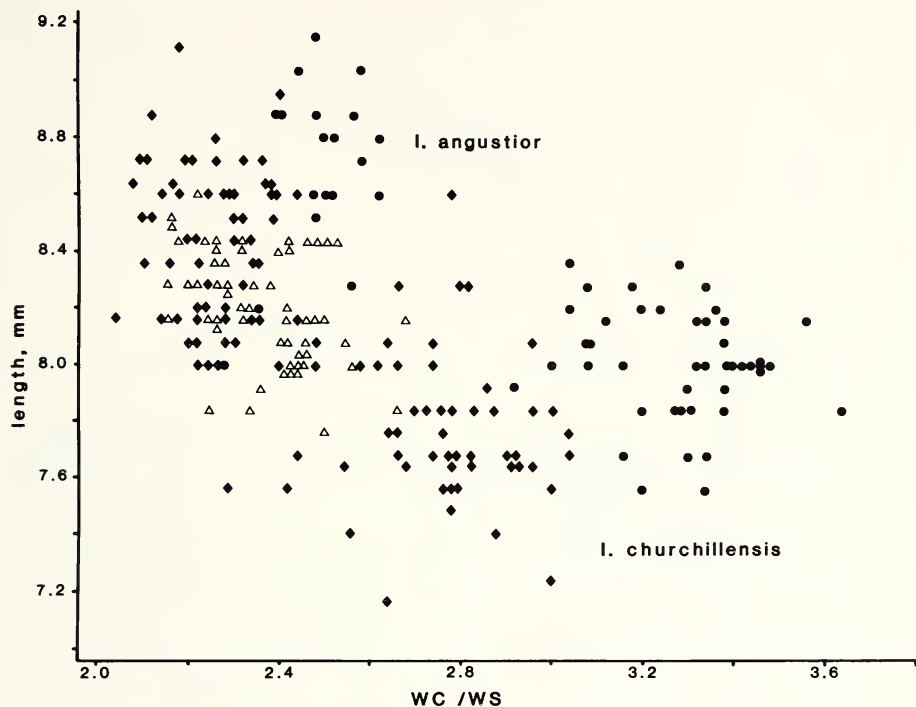
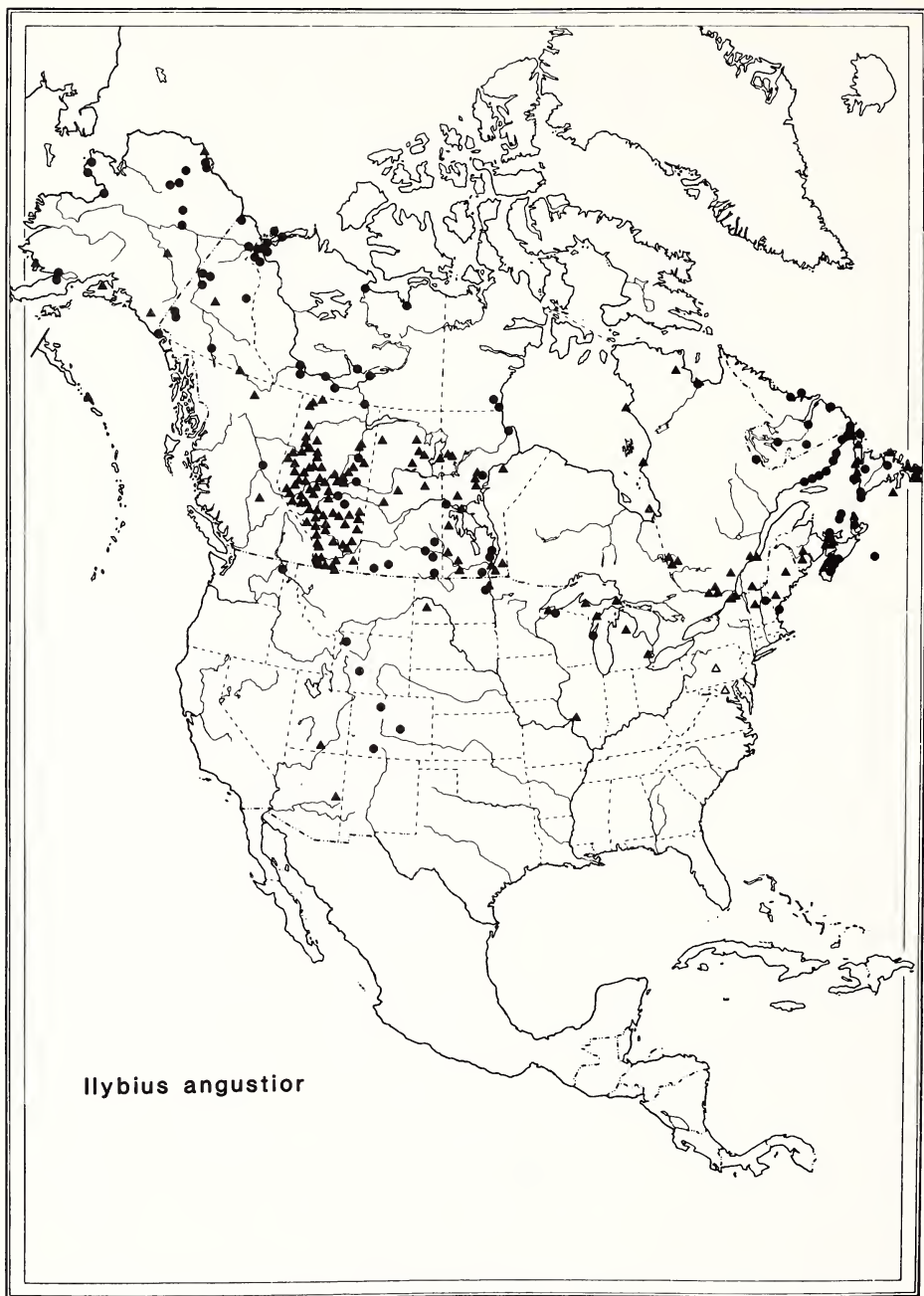


Fig. 74. Scatter diagram of length versus width for specimens of *I. angustior* and *I. churchillensis* from selected localities: closed circle—Churchill, Manitoba (both species); closed diamonds—Mackenzie Delta, N.W.T. (both species); open triangles—Coppermine, N.W.T. (*I. angustior* only).

The aggregate range of these species, which comprise the *I. angustior* group in North America, extends from the low arctic to the southern boreal region with *I. churchillensis* in the low arctic being the most northerly, *I. angustior* from the southern limits of the low arctic into the mid-boreal and northern prairie regions and along the Rocky Mountains, and *I. picipes* in mid- to southern boreal areas and maritime areas.

**Ecology.** This species occurs primarily in forested regions, in lentic sites where the water is shaded by dense stands of emergent vegetation, usually *Carex*. Specimens have been collected from prairie ponds but are seldom common in such habitats and are usually in transitional areas such as parkland or fescue prairie. The range of habitat overlap with other *Ilybius* species given by Larson (1985) is too broad and most co-occurrences with *I. discedens* are probably referable to *I. picipes*. Nilsson (1981) has described the larva and the life history in Sweden. Flight records extend from June 28 to July 14, with one record for October 1.

**Distribution.** The range is holarctic and primarily boreal. In North America the distribution extends from Newfoundland and Sable Island to Nome, Alaska, and from the arctic coast in the west, south along the Rocky Mountains to Colorado and New Mexico (Map 8).



Map 8. North American collection localities for *Ilybius angustior*. Closed circles—record confirmed by examination of male genitalia and metatarsal claws; closed triangles—record based on female specimens or not confirmed by examination of male genitalia and metatarsal claws, some of these records may be based on misidentified *I. picipes*; open triangle—state record.

Table 9. Measurements and ratios for selected population samples of *Ilybius churchillensis* Wallis.

Locality	N	Length L	Maximum width W	L/W	WC/WS
N.W.T., Reindeer Sta.	48	7.78 (0.27)	3.96 (0.13)	1.96 (0.04)	2.79 (0.13)
		7.18–8.58	3.70–4.29	1.89–2.07	2.44–3.04
Manitoba, Churchill	40	8.01 (0.20)	4.04 (0.11)	1.98 (0.03)	3.30 (0.10)
		7.55–8.36	3.85–4.29	1.90–2.08	3.00–3.64

*Ilybius churchillensis* Wallis, 1939

*Ilybius churchillensis* Wallis 1939:195. (Holotype—male, Churchill, Manitoba, in CNC.) (Type examined.)

*Selected references.* Wallis 1939:195.

*Description.* This species is similar to *I. angustior* but specimens are smaller (L—7.2 to 8.6 mm), narrower (L/W—1.89 to 2.08) and have narrower metasternal wings (Table 9, Fig. 74).

Color of dorsal surface mainly black, relatively shiny, specimens from the type locality with a green reflection but all other specimens examined lack green sheen. Frontal spots, anterior margin of clypeus, mouthparts and lateral margin of pronotum rufescent; elytron with lateral margin faintly piceous. Antenna yellow with distal antennomeres (on most specimens beginning antennomeres 3–5) distinctly infusate; palpi of most specimens with distal palpomere infusate apically. Legs dark rufous to piceous.

Elytron with meshes of sculpture coarser and more irregular in shape than on *I. angustior*, meshes without evident pattern of orientation or stretching; microreticulation evident apically but surface relatively shiny basally where microreticulation is only faintly impressed or absent.

Prosternal process short, apex acuminate and somewhat deflected upwards behind procoxae and out of plane of midline of prosternum in lateral aspect. Metasternal impression not or only just attaining level of hind margin of mesocoxal cavities. Metasternal wing narrower than in *I. angustior*, WC/WS—2.44 to 3.64.

Metacoxal plates with striae sparser and shorter than in *I. angustior*; striae irregularly oriented and variously interconnected especially medially on plate; on some specimens striae obscured by coarse reticulation and transverse rugae of plate; small punctures present both between and in striae. Metacoxal lines slightly arcuate anteriorly, finely traceable to metasternum or not.

Metafemur finely punctate, without striae. Metatibia with a series of coarse punctures along length of ventral face, punctures either forming a narrow medial series or punctate area expanded over most of ventral surface. Metatibial spurs slightly shorter than metatarsomere 1. Metatarsomere 1 with one to several ventrolateral setae.

MALE: Protarsal claws (Fig. 40) slender, similar to those of *I. angustior*. Metacoxae with a small medial keel on posterior portion of medial line. Metatarsomeres with a dorsolateral ridge: metatarsal claws (Fig. 54) slender, dorsal claw narrow and blade-like, its ventral (outer) margin not or only slightly expanded medially. Sternum 6 with a posteromedial keel, hind margin laterad to keel with coarse longitudinal



rugae. Subgenital plates strigate. Aedeagus (Fig. 68) slender, apex slightly reflexed ventrad and narrowly rounded.

**FEMALE:** Metatibia along inner margin and metatarsomeres externally lacking natatorial setae. Sternum 6 with medial emargination well developed, lateral angles rounded with a complete marginal bead: sides of emargination slightly pinched in posterior aspect.

*Variation.* This species shows considerable variation between the few population samples which I have examined. Measurements and ratios for the larger population samples examined are given in Table 9. Specimens from Churchill, Manitoba, have a distinct green reflection and are relatively large with narrow metasternal wings. Specimens from all other localities are entirely black without a green sheen. Towards the northwest, specimens are smaller but have relatively broader metasternal wings and tend to converge on *I. angustior* specimens which are also very small in this area (Fig. 74).

*Nomenclatural notes.* The species was described from 3 specimens (CNC) which I have examined. There is a long series of specimens from Churchill (O. Bryant, collector) in CAS, some of which I have, with permission of Dr. D. Kavanaugh, deposited in CNC, MUN, and USNM.

*Classification notes.* Male characters such as shape of dorsal metatarsal claw and apex of aedeagus are almost identical between *I. angustior* and *I. churchillensis* suggesting that *I. churchillensis* is closer to *I. angustior* than to *I. picipes*.

*Ilybius churchillensis* appears to replace *I. angustior* in the low arctic region west of Hudson Bay. Both species have been collected from several localities situated at the boundary between the low arctic and boreal regions. Although habitat data does not exist with most specimens, the fact that specimens of the two species have been collected on different dates or slightly different localities even when found in a region of sympatry, suggests that there is some habitat segregation or differentiation between the two species supporting the morphological segregation.

*Ecology.* The habitat has not been described. At Reindeer Station, N.W.T., A. Smetana (pers. comm.) collected specimens of *I. churchillensis* in tundra pools in upland habitat while collections in the Mackenzie River valley contained only *I. angustior*. There are no flight records.

*Distribution.* The species is known from only a few localities on the western arctic mainland, ranging from Churchill, Manitoba, to northern Alaska (Map 5).

*Ilybius picipes* (Kirby, 1837)

*Colymbetes picipes* Kirby 1837:17. Lectotype: selected by Persson 1985; male in BMNH from H.T. (Hudson Bay Territories), North America. (Type examined.)

*Selected references.* Persson 1985:266.

*Description.* This species is very similar to *I. angustior* and only the males can be recognized with confidence: the females are almost indistinguishable. Length 8.0 to 9.5, L/W—1.84 to 2.01. Measurements on selected population samples are given in Table 10.

Color averaging darker than on *I. angustior*, specimens usually with dorsal surface black medially, never with a metallic sheen. Antenna yellow with at least apical

Table 10. Measurements and ratios for selected population samples of *Ilybius picipes* Kirby.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Alaska, King Salmon	20	8.75 (0.25)	—	—	2.55 (0.08)
		8.36–9.18			2.40–2.67
Southern Ontario	13	8.89 (0.30)	4.70 (0.18)	1.89 (0.03)	2.62 (0.11)
		8.29–9.32	4.37–5.03	1.84–1.94	2.40–2.78
Michigan	9	8.91 (0.25)	—	—	2.56 (0.14)
		8.58–9.47			2.37–2.81
Labrador (males)	11	8.73 (0.36)	4.55 (0.20)	1.92 (0.02)	2.62 (0.09)
		8.29–9.32	4.29–4.88	1.89–1.97	2.42–2.74
Newfoundland (males)	20	9.05 (0.32)	4.72 (0.20)	1.92 (0.04)	2.62 (0.10)
		7.99–9.47	4.14–5.03	1.86–2.01	2.50–2.86

flagellomere infusate medially: palpi entirely pale or with apical palpomere of each palpus infusate. Ventral surface of body piceous to black: legs dark rufous to piceous.

Elytron (Fig. 10) with meshes of sculpture small, irregular in size and shape but generally somewhat rounded: lines deeper than in *I. angustior* and meshes more convex: microreticulation present apically but obsolete basally on most specimens. Elytra less shiny macroscopically, on average, than those of *I. angustior*.

Prosternal process and metasternum similar to that of *I. angustior* but differing as follows: lateral bead slightly broader between and behind procoxae, in ventral aspect process broader with sides evidently explanate at point of maximum width and shape of process more cordate. Metasternal wing broad, WC/WS—2.37 to 2.81, population means greater than for *I. angustior* (Table 10).

Metacoxal plate with striae elongate, irregular and variously intersecting to form an irregular meshwork. Metacoxal lines slightly sinuate, not or only faintly traceable to metasternum.

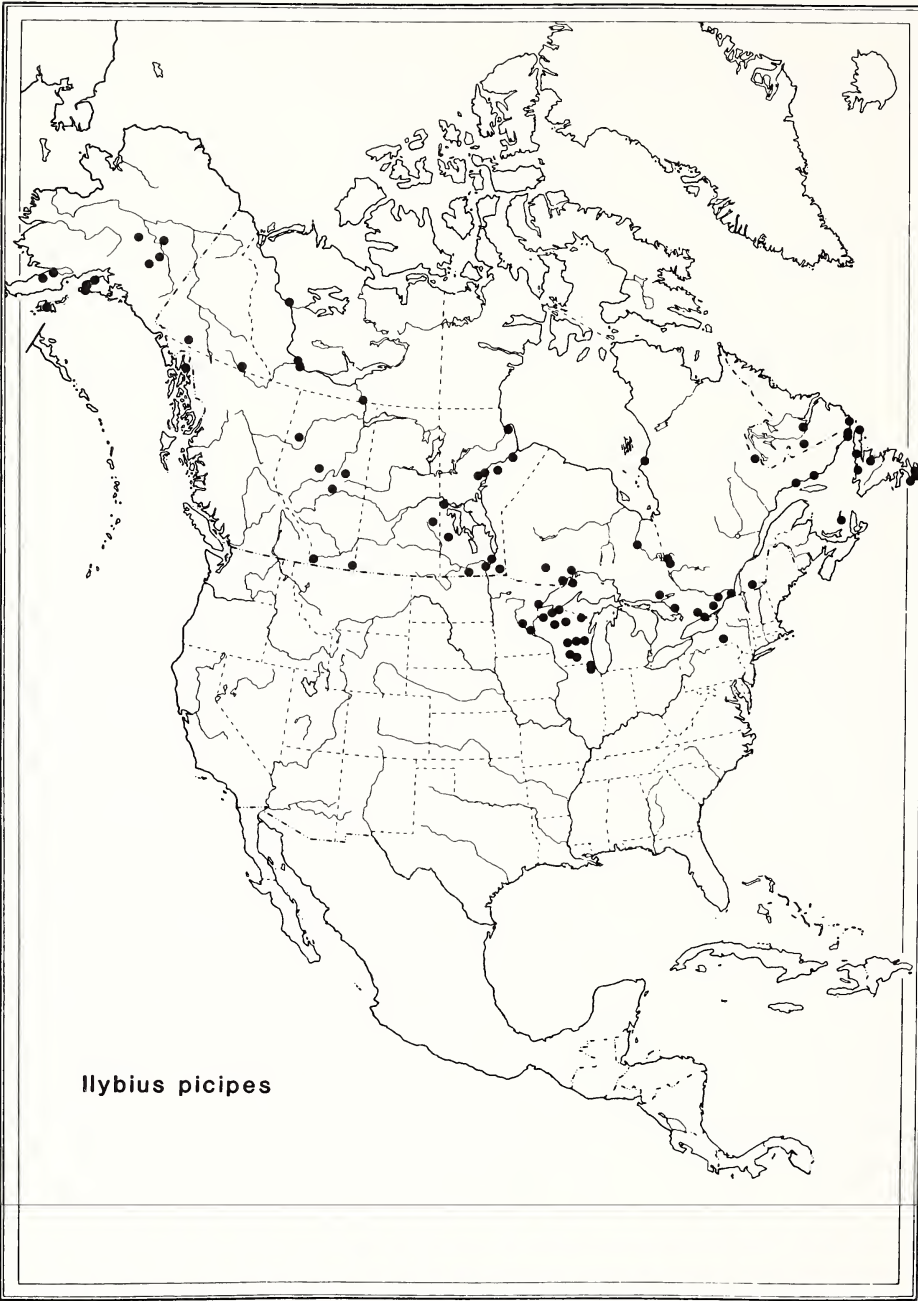
Metafemur punctate but lacking short, oblique striae. Metatibia with coarse punctures along entire ventral face. Larger metatibial spur subequal to metatarsomere 1. Metatarsomere 1 with one to several spines along ventroexternal margin.

MALE: Protarsal claws (Fig. 42) shorter, broader and more arcuate than those of *I. angustior*. Metacoxae with a small posteriomedial longitudinal keel. Metatarsomeres with a dorsoexternal ridge, ridge narrower than on *I. angustior*, especially on metatarsomere 4. Dorsal metatarsal claw (Fig. 55) narrower than in *I. angustior*, not evidently widened near middle. Sternum 6 and paramere as in *I. angustior*. Subgenital plate narrower apically than in *I. angustior*. Aedeagus (Fig. 69) with apex subparallel, bluntly pointed and not reflexed ventrally in lateral aspect.

FEMALE: Similar to *I. angustior*. Gonocoxa with dorsal margin straighter and apex more evenly tapered to a point than in *I. angustior*.

Variation. This is discussed under *I. angustior*.

Nomenclatural notes. *Ilybius picipes* has long been considered a synonym of *I. angustior*, but Persson (1985) has shown that the name refers to a valid species. I examined the type specimens without recognizing the validity of the species (Larson, 1975).



Map 9. North American collection localities for *Ilybius picipes*. Note—some of the closed triangles of Map 9 may represent collection records of misidentified specimens of *I. picipes*.

Table 11. Measurements and ratios for selected population samples of *Ilybius quadrimaculatus* Aubé.

Locality	N	Length L	Maximum width W	L/W	WC/WS
SW Alberta, & SE B.C.	10	10.70 (0.22)	5.67 (0.18)	1.89 (0.03)	2.55 (0.07)
		10.24–11.04	5.36–6.00	1.84–1.93	2.48–2.68
B.C., Mission City	14	10.07 (0.34)	5.41 (0.17)	1.86 (0.03)	2.71 (0.13)
		9.47–10.66	5.03–5.70	1.81–1.91	2.48–2.95
Alaska, Unalaska	15	10.38 (0.25)	5.50 (0.16)	1.89 (0.04)	2.73 (0.07)
		9.99–10.80	5.25–5.77	1.82–1.97	2.62–2.84

*Classification notes.* Initially on learning of Persson's conclusion that *I. picipes* was a good species, I had difficulty accepting its validity. However, after examining many hundreds of specimens from across North America, I found the slight differences in shape of the male pro- and metatarsal claws and aedeagus to be consistent, even in localities where both forms occur in sympatry. The distributions of the two differ slightly, with *I. picipes* tending to be more southerly or maritime in distribution than *I. angustior*, although *I. angustior* is the only species occurring in the Rocky Mountains of the contiguous United States.

*Ecology.* *Ilybius picipes* occurs in peatland pools in Newfoundland and Labrador while *I. angustior* has a broader range of habitats which include both peatland pools and marshes. Ecological distinctions between the two species have not been made elsewhere because of the difficulty involved in recognizing the species in the field. I have seen flight records for 4 and 27 June.

*Distribution.* *Ilybius picipes* has a holarctic distribution. In North America it is transcontinental in the boreal region. Collection records are indicated in Map 9. Only those collections that contain male specimens are indicated.

### *Ilybius quadrimaculatus* Aubé, 1838

*Ilybius quadrimaculatus* Aubé 1838:274. (Type area: "Amerique septentrionale".)  
Type not located.

*Selected references.* Larson 1975:376.

*Description.* This is a moderate sized (L—9.5 to 11.1 mm), elongate-oval (L/W—1.81 to 1.97) species. Ratios and measurements for three population samples are given in Table 11.

Color of body very dark, mainly black with anterior margin of clypeus, labrum, frontal spots, narrow lateral margin of pronotum and legs, dark rufous. Elytron with small postmedial vitta and subapical crescentic spot distinct on most specimens: disc medially faintly cupreous or aeneous on some specimens. Antenna rufous except antennomeres 5 to 11 infusate apically (palest specimens with at least antennomeres 10 and 11 infusate apically). Palpi pale with terminal palpomeres infusate apically.

Elytron (Fig. 11) shiny, meshes of sculpture relatively small, irregular in size and shape, on basal half of disc some meshes elongated or oblique but without forming distinct pattern of longitudinal stretching.



Prosternal process elongate and apically acuminate; in cross section strongly tectiform but narrowly rounded medially; sparsely setose basally but glabrous apically. Metasternal impression well developed and posteriorly attaining level of hind margin of mesocoxal cavities. Metasternal wings moderately broad (WC/WS—2.48 to 2.95).

Metacoxal plate shiny, with lightly impressed isodiametric sculpture and distinct but short and mainly separated striae, striae fine and relatively sparse; punctation evident. Metacoxal lines slightly arcuate anteriorly, not attaining metasternum.

Metafemur with numerous distinct but small punctures, striae absent. Metatibia with coarse punctures on basal third to half of ventral face, distally with sparse fine punctures except for row of coarse punctures along ventral mesal margin. Longer metatibial spur slightly longer than metatarsomere 1. Metatarsomere 1 without coarse ventral setae along ventrolateral margin.

MALE: Protarsal claws as in Figure 41: anterior claw with a distinct ventrobasal sinus; posterior claw shorter and narrower than anterior, with a distinct ventrobasal emargination. Metacoxae with a small posteriomedial longitudinal keel. Metatarsomeres 1 to 4 with a dorso-external bead: dorsal metatarsal claw (Fig. 56) evenly narrowed to curved apex. Sternum 6 (Fig. 23) with a large posteriomedial longitudinal keel, hind margin lateral to keel with coarse longitudinal rugae; marginal bead obsolete medially. Subgenital plate relatively narrow, truncate to shallowly and broadly emarginate apically, it and lateral plates strongly longitudinally rugose. Genitalia (Fig. 70) with paramere bearing short adhesive setae on mesal face; aedeagus elongate, longer than paramere and with apex spear-shaped in dorsal aspect.

FEMALE: Metatibia with mesal margin and metatarsomeres 1 to 3 with outer margins lacking natatorial setae. Sternum 6 (Fig. 29) shallowly and narrowly emarginate apically, lateral angle of emargination bluntly rounded and obtuse: in posterior aspect sides of emargination slightly pinched and medial portion raised as a distinct knob, this elevated knob extended anterad on sternum as a low but evident convexity traceable on many specimens over most of midline of sternum, many specimens with a fine longitudinal impression along middle of convexity just anterad of medial knob: lateral bead continuous around lateral angles of emargination.

*Variation.* The largest specimens are from western Alberta and southeastern British Columbia. These specimens also have slightly broader metasternal wings than those from more westerly localities. Too few population samples are available from central British Columbia to determine if variation in these characters is gradational or abrupt. The distinctive male genitalia is constant throughout the range supporting conspecificity.

*Nomenclatural notes.* I did not locate the type specimen. Neither the original description (Aubé, 1838) or the redescrptions by Crotch (1873) and Sharp (1882) provide sufficient detail to tie the name to the current species. Fall (1927) is the first to provide an adequate diagnosis for recognition of the species but he did not indicate on what basis he determined the application of the name. The current usage should be considered provisional until the type is examined.

*Classification notes.* This species shares with members of the *I. angustior* complex infusate antennae and palpi and a similar form of male sternum 6. On the other hand, the spear-like apex to the aedeagus in *I. quadrimaculatus* is distinctive and the metatibial punctation is reduced beyond that seen in any other North American member of the complex.

Table 12. Measurements and ratios for selected population samples of *Ilybius pleuriticus* LeConte.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Newfoundland, pooled	20	11.40 (0.41)	6.01 (0.24)	1.90 (0.04)	2.84 (0.14)
		10.65–11.91	5.55–6.44	1.81–1.97	2.56–3.15
Labrador, pooled	20	11.34 (0.50)	6.00 (0.24)	1.89 (0.05)	2.75 (0.10)
		10.21–11.99	5.48–6.36	1.76–1.97	2.56–2.95
N.B., Fred’cton	17	11.52 (0.43)	6.12 (0.26)	1.88 (0.04)	2.70 (0.03)
		10.58–12.28	5.48–6.44	1.81–2.00	2.42–2.95
Alberta, Smith	20	11.75 (0.47)	6.27 (0.28)	1.88 (0.04)	2.53 (0.10)*
		10.72–12.56	5.76–6.96	1.81–1.95	2.39–2.73

\* From Larson (1975), WS includes width of coxal rim.

The range of *I. quadrimaculatus* suggests the possibility of occurrence in the eastern Palaearctic region. However, I have not seen Old World specimens nor have I seen any Palaearctic species that approaches *I. quadrimaculatus* in aedeagal shape.

*Ecology.* This species occurs among emergent vegetation of permanent marshes, beaver ponds and backwater depositional zones of very slowly flowing streams. Specimens are often found in sites where the water is cool and there is some degree of flushing either by springs or the proximity of larger streams. There are no records of flight.

*Distribution.* The range of this species extends from the Aleutian Islands south to central California and east to the eastern slopes of the Rocky Mountains (Map 6).

*Ilybius pleuriticus* LeConte, 1850

*Ilybius pleuriticus* LeConte 1850:213. Holotype—female in MCZ labelled: pale blue disc/“♀” /“Type 6070”/“var. pleuriticus LeC.” (Type examined.) Type locality—Lake Superior.

*Ilybius inversus* Sharp 1882:552. Holotype—male, Hudson Bay, in BMNH (Type examined.)

*Selected references.* Larson 1975:375.

*Description.* Size large (L—10.2 to 12.6 mm), body moderately broad (L/W—1.76 to 2.00). Measurements for selected population samples are given in Table 12.

Color of dorsal surface piceous medially, with a faint brassy sheen on some specimens; lateral margins of body evidently reddish. Head with frontal spots, anterior portion of clypeus and labrum, rufous. Antenna and palpi pale, without infuscation. Pronotum with lateral margins broadly reddish, most specimens with anteriolateral angle red. Elytron with epipleuron and lateral margin broadly reddish, on some specimens reddish area extends onto disc almost to level of sublateral vitta: lateral and subapical spots evident. Ventral surface variously reddish to piceous: legs reddish.

Elytron with sculpture various, some specimens with meshes small and irregular in size but similar over most of disc; most specimens with meshes basally and medially very irregular in size and shape and appearing as though fusion of adjacent meshes has occurred to produce fewer elongated or curved meshes (Fig. 12): secondary reticulation present but on many specimens is more or less effaced on basal portions of elytron.

Prosternum with process moderately elongate and apically acuminate, tectiform in cross section with medial convexity narrowly rounded: lateral bead of process slightly broadened between and behind procoxae. Metasternal impression extending posteriorly to level of hind margin of mesocoxal cavities. Metasternal wings broad, WC/WS—2.5 to 3.2.

Metacoxal plates with short to moderately elongate, dense but mainly separate striae: sparse punctation evident. Metacoxal lines not attaining metasternum but longer than in *I. subaeneus*.

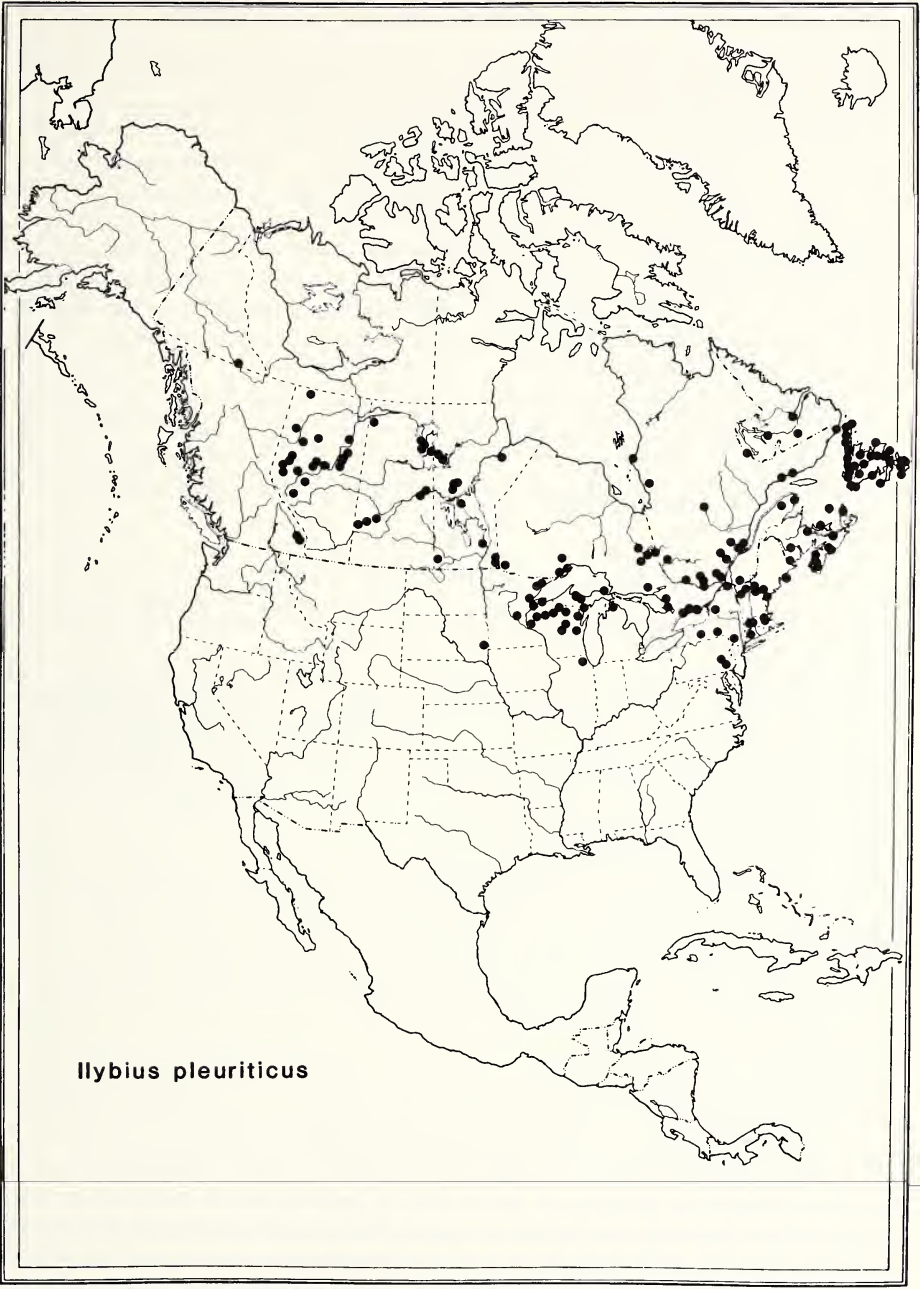
Metafemur finely punctate, a few punctures along hind margin obliquely elongated forming fine striae. Metatibia with punctures extending length of ventral face on most specimens but punctures irregular in size, usually coarse basally becoming finer towards distal half, or on some specimens punctures may be more or less obsolete on distal half. Longer metatibial spur slightly longer than metatarsomere 1. Metatarsomere 1 lacking ventrolateral coarse setae.

MALE: Protarsal claws as in Figure 43: anterior claw with basoventral sinus small; posterior claw with a distinct basoventral emargination. Metacoxae with a small medial keel. Metatarsomeres 1 to 4 with a dorsoventral ridge: dorsal metatarsal claw (Fig. 57) blade-like, slightly sinuate ventrally. Sternum 6 (Fig. 24) with a short posteromedial longitudinal carina: posteriolateral portions without longitudinal rugae or with a few shallow rugae but punctures evident: apex broadly rounded or subtruncate medially; marginal bead fine or obsolete medially. Subgenital plate truncate or shallowly emarginate apically, it and lateral plates with strong longitudinal rugae. Genitalia (Fig. 71) with paramere bearing numerous large, adhesive suckers along ventral margin: aedeagus short and blunt.

FEMALE: Metatibia with internal margin and metatarsomeres with external margins lacking natatorial setae. Sternum 6 (Fig. 30) relatively deeply emarginate medially; sides of emargination distinctly pinched in posterior aspect with middle somewhat produced: marginal bead of sternum broken or obsolete on externoapical angles of emargination and not traceable on most individuals. (On some specimens bead is shallow but evident on outer angles of medial emargination.)

*Variation.* This large species does not show any significant pattern of geographical variation over its range. One character with some individual variation is the lateral beading of sternum 6 of the female. The majority have the bead obsolete or broken just laterad of the outer angle of the medial emargination which provides a good character for identification. The bead is complete but shallow on some specimens, most frequently occurring on specimens from northern Quebec, Labrador and Newfoundland where up to 10% of specimens may have the bead more or less complete.

The extent of punctation of the ventral face of the metatibia also varies individually. The medial punctures are smaller distally on most specimens but are large enough throughout that a distinct series of punctures can be recognized along the entire length of the ventral surface. However, on a few specimens, the punctures are very small distally, almost as small as the micropunctuation of the metatibia of specimens of the *I. biguttulus* group. Such individuals can usually be recognized as *I. pleuriticus* because the punctures gradually become smaller from base to apex so that there is still evidence of a longitudinal series. Also, there are usually a few coarser punctures distally in the series. Such an inequality of distal puncture size does not occur in specimens of the *I. biguttulus* group.



Map 10. Collection records for *Ilybius pleuriticus*.



*Classification notes.* I associate *I. pleuriticus* with *I. subaeneus* because of similarities in color, sculpture, and certain sexual characters of the males such as the margined metatarsomeres, parameres with sucker hairs and similar forms of aedeagus. These species also share many of these features with the palaearctic *I. ater*.

*Ecology.* This species occurs in a rather wide range of permanent, lentic habitats, including *Carex* and rush filled marshes, amongst emergent vegetation along sheltered lake shores, and at the edges of larger ponds in peatlands. The association of *I. pleuriticus* and *I. discedens* indicated by Larson (1985) is due to both occurring in peatland ponds. Generally *I. discedens* is in smaller, colder pools and among *Sphagnum* while specimens of *I. pleuriticus* are usually in more sun-warmed sites and among emergent vascular plants so that there is a habitat segregation, although it may be narrow and both species are often taken in the same collection. Flight records exist for 30 May and 7 and 15 July.

*Distribution.* This species occurs from Newfoundland to the Yukon Territories in the boreal zone (Map 10). There is a specimen in the USNM labelled "Ft. Davis, Phantom L., Davis Mts., June 20, 1916, F. M. Gage." This Texas record is so far removed from any other collection locality that it must certainly be an error.

#### *Ilybius subaeneus* Erichson, 1837

*Ilybius subaeneus* Erichson 1837:156. (Type locality: Berlin, Brandenburg, Germany.) (Type not seen.)

*Ilybius viridianus* Crotch 1873:411. (Type locality: not restricted, described from specimens from Kansas and Hudson's Bay. Types not found in ANSP or MCZ.)

*Ilybius suffusus* Crotch 1873:411. Holotype—female, in ANSP, labelled: "I.T./"Il. suffusus Cr."/""HOLOTYPE, *Ilybius suffusus* Crotch 1873:411, det. D. Larson 1987." Type area given as "Indian Territory." **NEW SYNONYMY.**

*Selected reference.* Larson 1975:374.

*Description.* This is a moderately large (L—9.2 to 11.1 mm), oval (L/W—1.76 to 1.92) species characterized by a greenish reflection of the dorsal surface of the body. Measurements and ratios for selected population samples are given in Table 13.

Body dorsally mainly piceous to black with a distinct greenish sheen on most specimens. Anterior portion of head, frontal spots and lateral margins of pronotum and elytra reddish. Antenna and palpi entirely yellow. Ventral surface piceous. Legs reddish.

Elytron (Fig. 13) with meshes small, irregular in size and shape and without as pronounced a tendency of longitudinal or lateral elongation as seen in *I. pleuriticus*: meshes not longitudinally stretched on basomedial portion of disc.

Prosternal process elongate, acutely pointed apically: medial convexity narrower than in *I. pleuriticus*, carinate on apical half of process: lateral bead not or only slightly inflated between and behind procoxae. Metasternal impression well developed and extending posteriorly to level of hind margin of mesocoxal cavities. Metasternal wings broad, WC/WS—2.32 to 2.65.

Metacoxal plate with short striae, striae longest, densest and somewhat interconnected laterally, shorter and more or less isolated mesad on plate. Metacoxal lines short, disappearing well posterad of metasternum.

Metafemur with small punctures, some punctures along posterior margin elongate

Table 13. Measurements and ratios for selected population samples of *Ilybius subaeneus* Erichson.

Locality	N	Length L	Maximum width W	L/W	WC/WS
Labrador, Minipi L.	20	10.44 (0.22)	5.59 (0.14)	1.87 (0.02)	2.67 (0.15)
		10.06–10.80	5.33–5.77	1.82–1.91	2.45–3.00
Quebec, Mt. Albert	10	9.96 (0.20)	5.41 (0.13)	1.84 (0.04)	2.77 (0.09)
		9.62–10.29	5.11–5.55	1.76–1.90	2.63–2.89
N.W.T., Reindeer Sta.	20	9.83 (0.28)	5.34 (0.14)	1.84 (0.04)	2.56 (0.08)
		9.18–10.36	5.03–5.55	1.76–1.92	2.38–2.69
Saskatchewan, pooled	20	10.16 (0.29)	5.52 (0.17)	1.84 (0.03)	2.52 (0.09)
		9.62–10.16	5.10–5.77	1.78–1.92	2.28–2.69
Alberta, Peace R.	20	10.46 (0.22)	5.62 (0.14)	1.86 (0.03)	2.43 (0.08)*
		9.92–10.96	5.20–5.92	1.82–1.91	2.32–2.65
B.C., Tanzilla R.	4	9.51 (0.64)	5.05 (0.36)	1.88 (0.02)	2.63 (0.12)
		8.88–10.06	4.74–5.40	1.86–1.90	2.54–2.80
Colorado, Longs Peak	21	10.74 (0.23)	5.80 (0.13)	1.85 (0.03)	2.70 (0.10)
		10.29–11.10	5.55–5.99	1.79–1.92	2.52–2.90
Finland	4	9.90 (0.13)	—	—	2.50 (0.11)
		9.77–10.06			2.36–2.63

\* From Larson (1975), WS includes coxal rim.

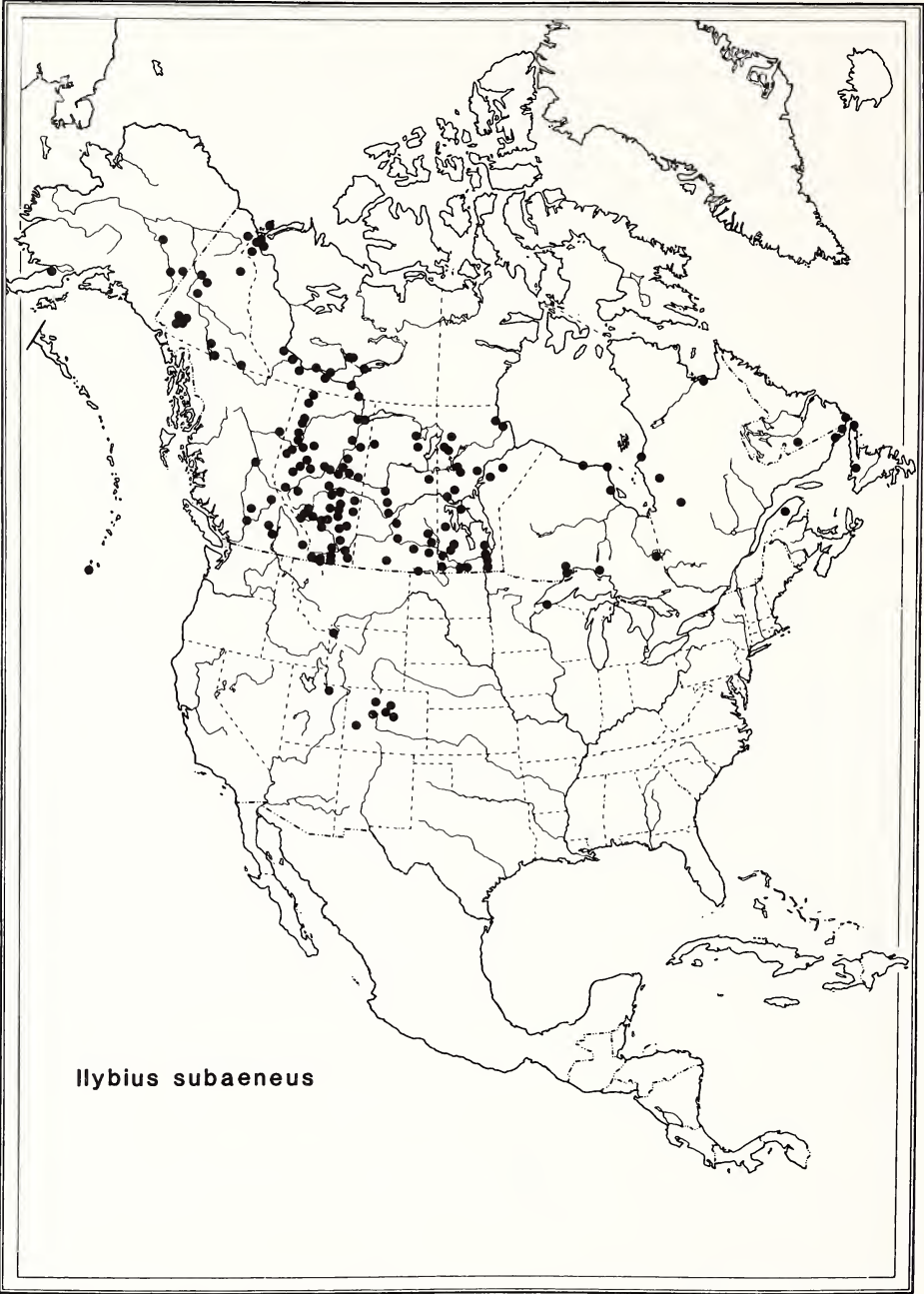
in form of short fine striae. Metatibia with coarse punctures along length of ventral face. Longer metatibial spur subequal in length to metatarsomere 1. Metatarsomeres lacking coarse dorsal and ventral setae.

MALE: Protarsal claws as in Figure 44, posterior claw narrow, ventral emargination broad and subbasal. Metacoxae with a short longitudinal keel on posterior portion of medial line. Metatarsomeres 1 to 3 with a dorsolateral bead: metatarsal claws as in Figure 58, dorsal claw broadly arcuate and tapering to apex. Sternum 6 (Fig. 25) with numerous coarse longitudinal rugae along posterior margin, these rugae obscuring setiferous punctures: a distinct medial longitudinal keel lacking; lateral bead obsolete across rugose portion of sternum. Subgenital plate broadly rounded to subtruncate apically, it and lateral plates coarsely longitudinally rugose. Genitalia (Fig. 72) with paramere bearing numerous adhesive setae along mesal face: aedeagus short, apex simple.

FEMALE: Metatibia with mesal margin and metatarsomeres with lateral margin lacking natatorial setae. Sternum 6 (Fig. 31) emarginate medially, lateral bead continuous around lateral angles of emargination.

*Variation.* Most specimens have a distinct metallic, usually green (sometimes coppery), sheen. Specimens with reduced, or lacking, metallic reflection occur so that color alone is not a reliable diagnostic character. Specimens in a series from Lake Nipigon, Ontario (Macdiarmid, ROM), have the lateral margins of the body broadly pale, with the pale area extending mesad of the sublateral vittae on some specimens and obscuring it. Very pale specimens of *I. confusus* (described by Wallis as *I. denikei*) also occur in the same general region, thus there appears to be an environmental factor promoting development of pale forms of *Ilybius*. The type specimen of *I. suffusus* Crotch has the lateral margins of the body broadly pale as described above.

Mean size varies among population samples (Table 13). The smallest specimens



Map 11. North American collection records for *Ilybius subaeneus*.

seen were from the northwest (northern B.C.; Reindeer Depot, N.W.T.), while specimens with the largest mean size were from Colorado. A clear geographical pattern in size variation is not evident and perhaps most variation is ecotypic. Samples from boreal sites have similar mean sizes while specimens from the prairies and eastern alpine sites average a little smaller.

Mean values for the ratios, L/W and WC/WS vary slightly among populations but in different patterns than that shown by length. Four Finnish specimens that I measured fell within the range of values observed among North American specimens.

*Nomenclatural notes.* *Ilybius viridianus* Crotch is listed as a synonym although the type was not examined. I did not locate it while examining the LeConte collection. Crotch's description includes the salient characters for species recognition so there is little doubt about this synonymy.

*Classification notes.* This species is most similar to *I. pleuriticus* and in fact some female specimens cannot be assigned to one species or the other with certainty.

*Ecology.* This species occurs in shallow, sun-warmed, usually permanent or semi-permanent lentic habitats. Specimens occur among emergent vegetation in both forest and grassland ponds. In Labrador, specimens are found principally in shallow water along sheltered lake shores, either among emergent plants or frequently on bare gravel or sand substrates. The larva has been described (Balfour-Browne, 1950; Nilsson, 1982). I have seen a single record of flight, 26 July.

*Distribution.* The species is holarctic. The North American range extends from the Northern Peninsula of Newfoundland, to the Aleutian Islands, Alaska, and in the west from the Mackenzie Delta to alpine areas of Colorado (Map 11).

#### SPECIES ERRONEOUSLY RECORDED FROM NORTH AMERICA

Several palaearctic species have been recorded from North America, or are represented in collections by specimens purported to be of North American origin. I consider the following species to be incorrectly attributed to North America because the records are based on single, old specimens with incomplete collection data and the occurrence has not been substantiated by recent, reliable records.

##### *Ilybius ater* (DeGeer, 1774)

*Colymbetes unguicularis* LeConte 1862:521 (Type examined—specimen in MCZ labelled: pink disc/"C. unguicularis Lec."/ "Type 6039"/ "I. unguicularis LeC. ater = Crotch") is a junior synonym of *I. ater* as stated by Crotch (1873). There is a second male in MCZ labelled "Indiana, Pa." I believe Wallis (1939) was correct in rejecting this as an American species.

##### *Ilybius fenestratus* (Fabricius, 1781)

This species was recorded from North America in some of the older literature, probably due to misidentification or misinterpretation of names (Balfour-Browne, 1950). There is a specimen in USNM labelled "Br. Col.," but the species is certainly not North American.



Table 14. Characters used in phylogenetic analysis of species of *Ilybius*. P—Plesiotypic state; A(n)—apotypic states(s).

Character	State	Description	Basis of comparison
1. Male genitalia sternum 9	P	oval plate with apex broad, rounded, truncate or bilobed	generalized ex-group
	A1	oval plate narrowly pointed apically	
	A2	oval plate with apex broadly rounded with a deep semicircular median notch	
2. Male genitalia aedeagus	P	basal guards well developed and semicircular	generalized ex-group
	A	guards small	
3-1. Male sternum 6	P	smooth, without longitudinal rugae	generalized ex-group
	A1	hind margin longitudinally rugose	
	A2	secondarily smooth through loss of rugae (some specimens with rudiments of rugae)	in-group
3-2. Male sternum 6	P	without posteriomedial longitudinal carina	generalized ex-group
	A1	medial carina present	
	A2	carina lost	in-group
4. Female	P	distinct V-shaped posteriomedial notch	generalized ex-group to determine plesiotypic state and in-group to establish direction of transformation
5. Metatibia, punctuation of ventral surface	A	notch shallow	generalized ex-group
	P	coarse punctures present along length	
	A	middle and distal portions impunctate or micropunctate	
6. Color of dorsal surface	P	dark dorsally, grading to paler lateral margins	generalized ex-group
	A1	broad, sharply defined lateral margins	

Table 14. Continued.

Character	State	Description	Basis of comparison
7. Habitus	A2	lateral margins broadly pale but gradually darkening onto disc	in-group, generalized body form throughout genus. Apotypic states based on in-group comparisons
	P	body oval, narrowed anteriorly and more so posteriorly, dorsally strongly convex	
	A1	body more elongate and dorsally flattened	
	A2 A3	body broader, depressed body broader and more rounded in dorsal aspect	
8. Posternal process	P	elongate, metasternal emargination extending to level of hind margin of mesocoxal cavities	generalized ex-group
	A	short, metasternal impression not attaining level of hind margin of mesocoxal cavities	
9. Elytral sculpture, punctation	P	punctures present at intersections of lines of primary sculpture	generalized ex-group
	A	punctures absent from intersections	
10. Male genitalia, paramere	P	parameres slender without subapical shoulder	generalized ex-group
	A	paramere broader, subapical shoulder prominent	
11. Male genitalia parameres	P	suckers absent from mesal face	generalized ex-group
	A1	suckers present	
	A2	suckers absent (secondarily) with patches of dense coarse setae in similar positions	

Table 14. Continued.

Character	State	Description	Basis of comparison
12. Female, metatibia and metatarsi	P	natatorial setae lacking from inner face of metatibia and outer surface of metatarsomeres	generalized ex-group
13. Male genitalia, aedeagus	A	natatorial setae present	generalized ex-group. Species specific forms considered apotypic
	P	subequal in length to parameres, symmetrical apex evenly narrowed	
	A1	elongate, apex flattened and recurved	
	A2	apex hooked	
	A3	apex with short lateral flanges, spear-shaped	
14. Male, metatarsus	A4	apex narrow, slightly reflexed	generalized ex-group
	P	dorsolateral bead absent	
15. Metacoxal wing	A	dorsolateral bead present	generalized ex-group
	P	broad, $WC/WS < 3.5$	
16. Elytral sculpture, primary meshes	A	narrow, $WC/WS > 3.5$	generalized ex-group; in-group for apotypy of species states
	P	meshes of more or less similar form over disc of various species or lines deeply impressed	
	A1	meshes granular	
	A2	meshes strongly elongated basally and medially on disc	
	A3	meshes irregularly fused and elongated	
17. Size	P	average size for genus	in-group
	A1	reduced size in lineages with sister taxa near average size	
	A2	increased size in lineages with sister taxa near average size	

Table 14. Continued.

Character	State	Description	Basis of comparison
18. Metacoxal plate sculpture	P	strioles well developed and intersecting	ex-group
	A	strioles reduced, short and separate or absent	in-group
19. Antenna, palpi color	P	entirely pale	in-group (infuscation widespread in agabines but of limited distribution in <i>Ilybius</i> )
	A	apical infuscation present	
20. Elytron, color	P	piceous or black, without metallic sheen	ex-group
	A	with metallic brass or green sheen	
21. Female, sternum 6	P	marginal bead complete around lateral angle of medial emargination	in-group
	A	marginal bead obsolete on lateral angle of medial emargination	
22. Metafemur, punctures	P	punctures rounded	ex-group and in-group
	A	some punctures along hind margin elongate, striolate	



*Ilybius fuliginosus* (Fabricius, 1792)

Balfour-Browne (1950) reviewed the history of North American records and concluded they were probably due to misidentification of various North American species. There is a male specimen of *I. fuliginosus* labelled "Pa." in MCZ and a male specimen labelled "Ind." in CNC but lack of supporting records suggests these are cases of mislabelling.

## PHYLOGENETIC CONSIDERATIONS

The taxonomic placement of the genus *Ilybius* has been discussed in a general way in the introduction. Although a more comprehensive study is required to determine its systematic position and to identify its sister taxon, present evidence strongly supports placing *Ilybius* in the tribe Agabini. Monophyly of the genus is clearly established by the synapotypic female ovipositor of the included species.

For purposes of deducing phyletic relations, generalized ex-group comparison of characters have been used to develop hypotheses regarding plesiotypic states. These comparisons were made between the species of *Ilybius* and other agabines, especially those members of *Agabus* that possess the plesiotypic character of an incompletely margined clypeus (Larson, 1975). In-group (between the species of *Ilybius*) comparisons were used for estimating direction of character change for those characters which have limited distribution among taxa of *Ilybius*. If two sister taxa differ in the states of a character, the state occurring in their sister clade is considered plesiotypic. Some character states are considered to be apotypic if the taxa bearing them are apotypic in a number of other features.

Descriptions of the characters used in this analysis, the character states recognized, and the rationale used in deducing direction of character transformation, are presented in Table 14. Interpretation of certain of these characters is problematical: such characters are discussed in more detail in the following section.

## DISCUSSION OF CHARACTER STATES

The characters used in the phylogenetic analysis are those of diagnostic value in the definition of taxa and have been described in the generic and species descriptions. Many of these characters occur in two states with the derived state apparently evolved once. Some characters show several states or the distributions of character states suggest convergence or reversals. Such characters are discussed below where rationale for interpretation of the character states is given. Reference is made in the character state discussions to points in the cladogram (Fig. 75) where specific states appear. Capital letters refer to the similarly labelled bifurcation points in the cladogram while lowercase a and b refer to left and right branches respectively.

Characters 3.1 and 3.2—male sternum 6. The sculpture of the hind margin of the sternum is highly varied among species of the genus and affords some of the best characters for species recognition. The sculpture consists of the presence or absence of longitudinal rugae, a medial longitudinal keel (carina) or both in various combinations. I interpret the medial carina as secondarily derived from the rugose sculpture through the narrowing and raising of a medial ruga. I make this interpretation because I know of no other agabine outside of *Ilybius* that possesses an abdominal keel although several species of *Agabus* possess longitudinal rugae. A keel is present in a number of groups of *Ilybius* where rugae are also widespread among the group



6 of members of the *I. apicalis* group is plesiotypic. The lack of rugae in members of the *I. biguttulus* group is regarded as a secondary loss because some members of the group possess a median keel, which being derived from rugae would mean that an ancestor possessed rugae. As all species of *Ilybius* other than those of the *I. apicalis* group have either rugae, a medial keel or show strong affinity with species that do, I conclude the stock common to all *Ilybius* exclusive of the *I. apicalis* group possessed at least a rugose sternum 6 (Ab, 3-1A1). Subsequent modification of this state was loss of medial rugae (Ba, 3-1A2), the development of a medial keel with rugae present (Cb, 3-2A1), or loss of various elements of this system, e.g., rugae present, carina secondarily lost (Jb, 3-2A2), carina present and rugae lost (Ja, 3-1A3), or rugae and carina secondarily lost (Ib, 3-1A2, 3-2A2).

The median keel appears in lineages after the initial acquisition of rugae (Cb, 3-2A1). The occurrence of the keel in *I. biguttulus* and *I. ignarus* is difficult to explain. The model presented here involves two independent acquisitions of a medial keel (Cb, Ia, 3-2A1). The alternative, the common origin for the keel from Bb, would require postulation of secondary losses at Da, Fa and Ib. Parsimony was the basis for choosing the pattern presented but parallel independent losses is more probable than parallel independent acquisitions of a character, given similar numbers of transformations.

Character 4—female sternum 6. The medioapical emargination is a synapotypy that unites the members of the genus and is correlated with the possession of saw-like gonocoxae. The emargination is deep and V-shaped in most species but in members of the *I. apicalis* group (Aa) the notch is very small. Although not so reduced as in the *I. apicalis* group, the emargination is relatively shallow in the *I. biguttulus* group (Db) as well as in several palaearctic members of the *I. angustior* (Eb) group. The character is gradational and difficult to assess.

Character 5—Metatibia, punctuation of ventral face. All *Ilybius* species have punctures on the ventral face of the metatibia, but the size and distribution of punctures varies considerably among (sometimes even within) species. It is postulated that the plesiotypic state is coarse punctures along the length of the ventral face. From this state, parallel losses of coarse punctuation occur at Aa, Ca and Ga. *Ilybius pleuriticus* specimens show reduced size and numbers of punctures and suggest an intermediate stage towards loss (Ja).

Character 6—color of dorsal surface of body. Specimens of *Ilybius* are basically dark (piceous or black) beetles in which the margins of the body are variously paler. Members of the *I. apicalis* group have broad yellow margins to the pronotum and elytra with these margins abruptly limited to the disc (Aa, 6A1): the venter is reddish yellow. This color pattern also occurs in *I. fuliginosus* which belongs with species of clade Eb. Broad but gradually paler lateral margins (6A2) occur in *I. pleuriticus*, *I. confusus* and some populations of *I. subaeneus*.

Character 7—habitus. Most *Ilybius* are recognizable on habitus as their bodies are narrowly rounded both towards the head and even more so apically, while in lateral aspect they are strongly convex dorsally and flattened ventrally. Modifications of this form are shown by: members of the *I. apicalis* group which are elongate and flattened (Aa, 7A1) and *I. vittiger* which is broad and depressed (Hb, 7A2). Members of the *I. biguttulus* group (Db) tend to be broader in outline than members of the *I. angustior* group (Cb) but the differences are slight and exceptions occur among species in each group so that the character is equivocal for phylogenetic analysis.

Character 8—prosternal process. Length of the prosternal process varies among species of the genus. An elongate prosternal process that is received into a deep emargination of the metasternum (extending posteriorly to at least level of hind margin of mesocoxal cavities) is considered plesiotypic. Shortening of the process occurs independently in *I. lateralis* (palaeartic), *I. vittiger* and *I. oblitus* and to a lesser degree in *I. churchillensis* and as such is associated with elongation, flattening or broadening of the body. The functional significance of shortening of the process is not apparent although it would appear to permit increased flexibility of the prothorax enhancing crawling or burrowing capability but probably with reduced swimming efficiency.

Character 13—male genitalia, aedeagus. The form of the aedeagus tip varies among species and provides some good diagnostic characters for species recognition. However, the generally similar form throughout the genus provides few good characters for defining supraspecific groupings.

Character 15—metasternal wing. The width of the lateral portion of the metasternum varies considerably. Through generalized ex-group comparison, the plesiotypic condition is believed to be broad (WC/WS—2.00 to 3.50). Narrowing occurs in several separate lineages, most strongly so in Fa and to a lesser degree, Na as well as in several palaeartic species. The character is most useful for species diagnosis. The significance of the narrowed metasternal wing is not known but it has been postulated as being related to reduced flight capability (Jackson, 1952).

Character 16—elytral sculpture. Two levels of sculpture occur on the elytra which in the terminology of Larson (1975) are: primary—coarsest lines and the meshes or interspaces between them; and secondary—which is comprised of much smaller and finer lines which produce a fine, reticulate sculpture on the meshes of the primary sculpture. The secondary sculpture is more or less consistent throughout the genus and varies mainly in the degree of effacement of lines which occurs on most specimens on the basal or medial portions of the elytral disc. Variation in the primary sculpture occurs as: deepening of lines so that meshes appear more raised or granular (16A1); longitudinal stretching or elongation of meshes (16A2); or fusion of adjacent meshes due to short sections of the primary lines disappearing (16A3). State 16A2 is best developed in lineages Da and Ib but it also suggested in some specimens of *I. biguttulus* (Ma).

Character 17—size. Although all members of the genus are moderately large dytiscids, size varies considerably between species. Size variation probably has more of an ecological than phylogenetic basis. For example, the smallest species, *I. discedens*, *I. vittiger* and *I. ignarus* are peat pool species, while the largest species are those most frequently found along the margin of larger water bodies, e.g., *I. pleuriticus* and *I. confusus*.

#### PHYLOGENY OF NORTH AMERICAN SPECIES OF *ILYBIUS*

The cladogram presented in Figure 75 diagrammatically represents phyletic relationships hypothesized among North American and select palaeartic species of *Ilybius*. The palaeartic species, *I. apicalis* and *I. cinctus*, are included as they appear to be the sister group (Aa) to all other *Ilybius*. The name *Agabidius* Seidlitz is available for this clade which I consider distinct enough to warrant subgeneric rank.



The two species of clade Ba, *I. discedens* and *I. vittiger*, are small, northern, peat pool species. They possess a number of characteristics in common but as discussed above, most of these are synplesiotypies so the relationship may not be very close. Differences in such features as habitus, aedeagus, female sternum 6, and natatorial setae on the hind legs of female *I. discedens*, suggest relationship is distant. While *I. discedens* is phyletically isolated and possesses enough distinctive features to be placed in a subgenus separate from the members of clade Bb, *I. vittiger* is in some ways bridging. I feel introducing subgeneric ranking for a species of such uncertain phyletic relationships to be inadvisable at present.

Clade Cb is a well defined, apparently monophyletic group characterized by males with the synapomorphic laterally beaded metatarsomeres. This group contains six North American species, half of which are holarctic, as well as the majority of the palaearctic species.

Clade Ca is less certainly monophyletic for the group is based largely on negative or plesiotypic characters. The species of clade Db are a natural group as evidenced by the very similar male genitalia. The members of this clade are North American with no close palaearctic relatives. The North American range is centered mainly in the northern Appalachian region but one species, *I. biguttulus*, extends into the southeastern boreal region as well as across the central plains into the southern Rocky Mountains. The position of *I. fraterculus* is enigmatic. The lack of suckers on the parameres, the apically hooked aedeagus and the deeply emarginate female sternum 6 separate this species from the other members of clade Ca. On the other hand, these male characters as well as the tendency for the primary elytral sculpture to be longitudinally stretched also separate the species from the members of clade Cb. For the present, the position of *I. fraterculus* as the western North American sister species to the stem of clade Db seems to be the best solution to its placement.

Two peculiar palaearctic species, *I. fenestratus* and *I. similis*, belong in clade Bb but differ from the members of both clades Ca and Cb on a number of features and are not obvious sister taxa of either. Their placement is discussed in the following section.

The remaining relationships are discussed under the individual species accounts and indicated in Figure 75 and need no additional explanation.

#### SYSTEMATIC NOTES ON PALAEARCTIC SPECIES

*Ilybius aenescens* Thomson, 1870:125.

Plesiotypic Characters—1, 2, 4, 6, 7, 8, 12, 13, 15, 17, 19, 20, 21.

Apotypic Characters—3-1A2, 3-2A1, 9, 10, 11A1, 14, 18.

Variable Characters—5, 16, 22.

Topological Position—This species shares many similarities with the taxa of branch Eb but lacks infuscation of antennae and palpi, shows reduction or loss of male sternum 6 rugae, reduced metacoxal plate striae, reduced metatibial punctation and a longitudinal stretching of basomedial elytral meshes. This is probably the sister taxon of clade Gb.

*Ilybius apicalis* Sharp 1873:51.

The phylogenetic interpretation of character states of this species are indicated in Figure 75. Zaitzev (1953) and Leech (1955) consider *I. apicalis*, *I. cinctus* Sharp and

*I. lateralis* (Gebler) to be closely related. I recognize the close relationship between *I. apicalis* and *I. cinctus* but regard the similarities with *I. lateralis* as convergent (see *I. lateralis* below).

*Ilybius ater* (DeGeer 1774:401).

Plesiotypic Characters—1, 2, 4, 5, 7, 8, 12, 15, 18, 19, 20, 21.

Apotypic Characters—3-1A2, 3-2A1, 6A2, 9, 10, 11A1, 17A2, 22.

Variable Characters—16.

Topological Position—This is the largest species of the genus. The aedeagus is diagnostic, long and slender with basal piece bent at an angle greater than 90° from longitudinal axis of shaft. Strioles of the metatibia are very strongly developed. Elytral sculpture is sexually dimorphic with the male form plesiotypic. This species possesses the apotypic characters of clade Ea and appears to be the palaearctic sister species of *I. pleuriticus* (Ja).

*Ilybius cinctus* Sharp 1882:560.

The phyletic position of this species is indicated in Figure 75 and discussed under *I. apicalis* above. Zaitzev (1953) regards *I. angustulus* Regimbart 1899:289, and *I. chinensis* Csiki 1901:102, to be junior synonyms of *I. cinctus*.

*Ilybius crassus* Thomson 1856:224.

Plesiotypic Characters—1, 2, 4, 5, 6, 8, 12, 13, 15, 17, 18, 19, 20.

Apotypic Characters—3-1A1, 3-2A1-A2, 7A3, 9, 10, 11A1, 14, 16A1-A2, 21, 22.

Topological Position—Male sternum 6 longitudinally rugose but rugae more or less obsolete medially (convergent with clade Ba), lacking a distinct keel but with a medial tumid area interpreted as an obsolete keel. The aedeagus is short and blunt and similar to that of *I. pleuriticus*. Lines of elytral sculpture are deep and meshes slightly elongate, especially on female. The species is closest to clade Ea. *Ilybius weymarni* Balfour-Browne 1947 is very similar and the name is probably a junior synonym of *I. crassus*.

*Ilybius fenestratus* (Fabricius 1781:294).

Plesiotypic Characters—2, 4, 12, 14, 17, 19, 21.

Apotypic Characters—1A2, 3-1A1, 3-2A1, 5, 6A2, 7A3, 8, 9, 10, 11A1, 13, 15, 16A3, 18, 20, 22.

Topological Position—This species and *I. similis* (see below) occupy a rather isolated position within the palaearctic fauna. They are best placed in the cladogram at node C but they possess such a unique combination of plesiotypic and apotypic characters that they do not fit into either clade Ca or Cb. They probably represent a sister group to clade Cb. In addition to the characters enumerated above, other species specific features are: elytron with meshes of primary sculpture irregular but with some tendency for transverse stretching; and aedeagus very elongate.

*Ilybius fuliginosus* (Fabricius 1792:191).

Plesiotypic Characters—1, 2, 4, 8, 12, 13, 15, 16, 17, 19, 22.

Apotypic Characters—3-1A1, 3-2A1, 5, 6A1, 7A1, 9, 10, 11A1, 14, 18, 20, 21.

Topological Position—Color is similar to that of taxa of clade Aa, but most structural characters including the laterally beaded male metatarsomeres and male genital

characters place the species in the clade Cb. *Ilybius meridionalis* Aube 1836:126, a species found in the Mediterranean region, is similar in all characteristics except it possesses narrower metasternal wings.

*Ilybius guttiger* (Gyllenhal 1808:499).

Plesiotypic Characters—1, 2, 4, 6, 7, 8, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22.

Apotypic Characters—3-1A2, 3-2A1, 9, 10, 11A1, 14.

Variable Characters—5, 16.

Topological Position—This species very closely resembles *I. aenescens* occupying a similar position in the cladogram.

*Ilybius lateralis* (Gebler 1832:40)

Plesiotypic Characters—1, 2, 9, 10, 12, 13, 15, 16, 19, 20, 21, 22.

Apotypic Characters—3-1A2, 3-2A2, 4, 5, 6A1, 7A1, 8, 11A1, 14, 17A1, 18.

Topological Position—This species is difficult to place as it possesses a very peculiar combination of characters. In general habitus, as well as in many specific details, it resembles specimens of clade Aa, with which it was associated by Zaitzev (1953) and Leech (1955). Male characters such as laterally beaded metatarsomeres, and parameres with suckers, place it in clade Cb. The shared similarities with members of clade Aa are probably convergent.

*Ilybius obtusatus* Sharp 1882:558.

Plesiotypic Characters—4, 5, 6, 7, 9, 12, 15, 16, 17, 18, 20, 21, 22.

Apotypic Characters—8, 19.

Topological Position—I have seen only the female holotype, thus male characters have not been scored. Based on female characters, the species is most similar to members of clade Ba. This implies the males should have the following characters: metatarsomeres lacking lateral bead; parameres without a defined shoulder and lacking suckers; and sternum 6 with rugae posteriolaterally, smooth medially and lacking longitudinal carina. Zaitzev (1953) described the male as having laterally ridged metatarsomeres and sternum 6 with a weak medial keel and strong lateral rugae. It is possible that Zaitzev's description applies to another species, but it he was correct the peculiar combination of characters will necessitate a reevaluation of the position of clade Ba.

*Ilybius quadriguttatus* (Lacordaire 1835:316).

Plesiotypic Characters—1, 2, 5, 6, 7, 8, 12, 13, 15, 16, 18, 19.

Apotypic Characters—3-1A2, 3-2A1, 4, 9, 10, 11A1, 14, 17A2, 21, 22.

Topological Position—The male genitalia and margined metatarsomeres place this species in clade Cb. The larger than average size, pale antennae and palpi and striolate punctures of the metafemur indicate an affinity with clade Ea. The emargination of female sternum 6 is shallow for members of this group. A species-specific character of the male is the presence of an usually distinct tooth medially situated on the ventral margin of the posterior protarsal claw.

*Ilybius similis* Thomson 1856:225.

Plesiotypic Characters—2, 4, 5, 6, 7, 8, 12, 13, 14, 15, 17, 18, 19, 20.

Apotypic Characters—1A2?, 3-1A1, 3-2A1, 9, 10, 11A1, 21.

## Variable Characters—16, 22.

**Topological Position**—This species shares many features (both plesiotypic and apotypic) with *I. fenestratus* and is probably its sister species. Together these species are rather isolated from other species of *Ilybius*. Male sternum 9 is very broad, as in *I. fenestratus*, but has only a small apical emargination as opposed to the deep semicircular notch of *I. fenestratus*. In spite of this difference, both are considered to represent the same character state.

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## A REVISION OF THE *OZOPHORA UMBROSA* COMPLEX IN THE WEST INDIES (HEMIPTERA: LYGAEIDAE)

JAMES A. SLATER

Department of Ecology and Evolutionary Biology, University of Connecticut,  
Storrs, Connecticut 06268

**Abstract.**—A complex of species of *Ozophora* in the West Indies is discussed and a key presented to distinguish the species. Two new species are described: *Ozophora umbrosa* (widespread in the Greater Antilles and known to occur in the Bahamas) and *Ozophora archboldi* known only from Dominica. *Ozophora fuscifemur* Scudder, known from Little Cayman I. and Cayman Brac, is reduced to a subspecies of *Ozophora pallidifemur* Scudder from Grand Cayman. *Ozophora levis* Slater and Baranowski is reported from several islands of the Bahamas. There are descriptions of the nymphs and notes on the habitat of *Ozophora umbrosa*. Twelve illustrations of distinguishing details of the genitalia are included.

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The West Indies contains a wealth of species of the genus *Ozophora*. Obviously the genus has radiated extensively from several mainland sister group sources.

One of the most difficult complexes to understand has been a group of species distinguished primarily by their predominantly dark chocolate brown coloration that contrasts strikingly with pale yellow maculae or elongate stripes on the hemelytra. Whether or not this complex will prove to be a monophyletic group within *Ozophora* must await studies now underway on the extensive Central and South American faunas. However, whether monophyletic or not, the various taxa are difficult to distinguish from one another and the present paper is an attempt to clarify taxonomic relationships within the islands and to provide a means of identifying the species.

In summary the following taxa are involved.

1. *Ozophora levis* Slater and Baranowski—found on the Florida Keys and in the Bahamas.
2. *Ozophora pallidifemur* Scudder (with a subspecies *fuscifemur*)—endemic on the Caymans.
3. *Ozophora umbrosa* new species—found throughout the Greater Antilles and in the southern and central Bahamas.
4. *Ozophora archboldi* new species—endemic on Dominica.

All of these species are about "average size" for the genus (5–7 mm) with calloused but not sharply carinate lateral pronotal margins, rounded or slightly angulate humeral angles, usually with a large white fourth antennal annulus and with the membrane of the front wing a completely dark smoky gray.

The most common and widespread species is *Ozophora umbrosa*. It stands in many collections as *Ozophora atropicta* Barber. However, as indicated by Slater and Hassey (1981) Barber's type series was mixed and the holotype of *atropicta* is a species not closely related to this group, thus leaving this widespread and common species without a name.

All measurements are in millimeters.

KEY TO SPECIES OF THE *OZOPHORA UMBROSA* COMPLEX

1. Dorsal surface of body with many upstanding hairs present (short in *pallidifemur*) . . . 2
- Dorsal surface of body almost glabrous . . . . . 4
2. Labium elongate extending onto third abdominal sternum; hairs on dorsal surface numerous and elongate (Dominica) . . . . . *archboldi* n. sp.
- Labium at most slightly exceeding metacoxae; dorsal hairs short and inconspicuous . . . . . 3
3. Femora pale yellow (Grand Cayman) . . . . . *pallidifemur pallidifemur* Scudder
- Femora reddish or dark brown (Little Cayman; Cayman Brac) . . . . .  
. . . . . *pallidifemur fuscifemur* Scudder
4. Males with cup-like sclerite of genital capsule very broad, truncated and heavily sclerotized at outer ends (Fig. 1) . . . . . *umbrosa* n. sp.
- Males with arms of cup-like sclerite elongate, slender, not truncate and not heavily sclerotized distally (Fig. 2) . . . . . *levis* Slater and Baranowski

***Ozophora umbrosa*, new species**

Figs. 1, 4, 7, 11, 12

*Description.* General coloration dark chocolate brown. Marked with pale yellow as follows: anterior pronotal collar on either side of midline; narrow lateral margins of anterior two-thirds of pronotum; a small yellow macula immediately behind transverse impression on either side of midline of posterior pronotal lobe; humeral angles of pronotum; a small macula along posterior pronotal margin midway between meson and humeral angle; a pair of diagonal pale vittae on scutellum laterally; a pale patch basally on corium laterad of radial vein; an elongate narrow pale stripe adjacent to costal margin at level of claval commissure; a large macula on distal third and extreme apex of corium. Membrane fumose throughout, lacking a pale apical stripe. Pleural and sternal surfaces nearly uniformly dark chocolate brown, but with dorso-caudal angle of metapleuron pale yellow. Coxae, fore femora and distal four-fifths of middle and hind femora dark red brown. Remainder of legs testaceous. First antennal segment, distal one-fourth of second, distal one-third of third, extreme base and apical one-half of fourth dark red to chocolate brown; remainder of segments 2 and 3 light yellowish brown; proximal one-half (except for extreme base) of fourth segment a strongly contrasting white.

Head short, only slightly declivent; tylus reaching middle of first antennal segment. Eyes large, ovoid, sessile, covering most of lateral head surface. Length head 0.80, width 0.88, interocular space 0.40. Pronotum somewhat campanulate, posterior margin very shallowly concave; lateral margins deeply concave and considerably narrowed across anterior lobe as compared with distance across humeri; transverse impression shallow but complete; anterior collar strongly differentiated; calli confluent mesally; pronotal punctures discrete, well developed on posterior lobe and anterior to calli before collar. Length pronotum 0.96, width 1.40. Length scutellum 0.84, width 0.72. Hemelytra with lateral corial margins very slightly sinuate at level of apex of scutellum. Clavus with numerous irregular punctures not forming distinct rows except laterally on either side of elevated cubital vein. Length claval commissure 0.66. Midline distance apex clavus-apex corium 1.20. Midline distance apex corium-apex abdomen 0.84. Labium rather elongate, extending well between metacoxae, first segment almost reaching base of head. Length labial segments I 0.84, II 0.76, III 0.64, IV 0.40. Length antennal segments I 0.76, II 1.56, III 1.28, IV 1.60. Total body length 5.20.

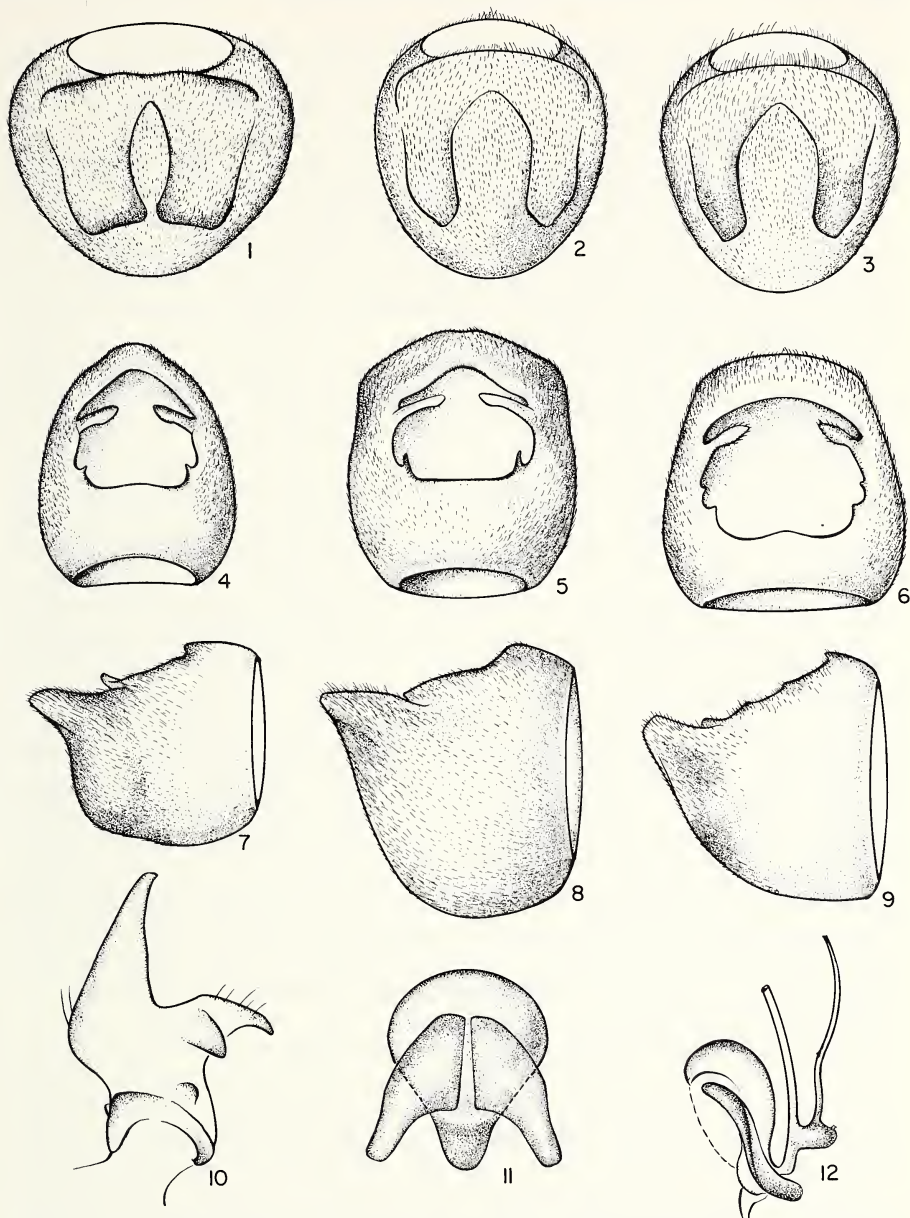


Cup-like sclerite of genital capsule very broad, truncated, thickened and heavily sclerotized at outer ends (Fig. 1). Genital capsule bluntly produced posteriorly at dorsal margin (Fig. 7), with dorsal opening in which parameres lie broadly expanded caudally (Fig. 4).

Paramere similar to *levis* but variable with inner projection thick, sometimes not strongly bent downward; blade relatively straight; basal flange often broadened toward inner margin. Sperm reservoir (Figs. 11, 12) with broad cup strongly tapering basally and distally narrowed wings.

*Holotype*. ♂, JAMAICA: *St. Ann Parish*: 3 miles W Ocho Rios. 4.VII.1971 (J. A. Slater, R. M. Baranowski, J. E. Harrington). In American Museum of Natural History.

*Paratypes*. JAMAICA: 6♂♂, 12♀♀, same data as holotype. 15♂♂, 13♀♀, 3 miles W Ocho Rios 11.XII.1970 (R. M. Baranowski & J. A. Slater). 1♂, 3♀♀, *St. Anne's*, Runaway Bay 25.VII–10.VIII.1971 (S. S. Duffey). 1♂, same 10.V.1970. 2♂♂, same 21.VI.1970. 1♂, same 28.VI.1970. *Clarendon Parish*: 2♂♂, 3♀♀, Portland Ridge PWD Fish Camp 20.VIII.1969 (R. E. Woodruff) (Blacklight trap). 1♂, Milk River Bath 14.V.1965 (R. E. Woodruff) (Blacklight trap). *St. Catherine Parish*: 1♀, Worthy Park Estate 21.XI.1968 (R. E. Woodruff) (Blacklight trap). 2♂♂, same 10.XI.1968. 1♀, same 11.V.1969. 1♂, same 16.XI.1968. 1♂, Worthy Park Estate 3.VI.1970 (E. G. Farnsworth) (Blacklight trap). *St. Andrew Parish*: 1♀, Bamboo Lodge nr. Irishtown 2,500 ft. 19.VIII.1972 (R. M. Baranowski) (Blacklight trap). *Trelawney Parish*: 4♂♂, 1.9 mi. N. Burnt Hill 16.V.1969 (R. E. Woodruff) (Blacklight trap). DOMINICAN REPUBLIC: 9♂♂, 10♀♀, *Prov. Pedernales*, 21 KM N Cabo Rojo 18.VI.1976 (R. E. Woodruff). 2♂♂, 1♀♀ same 19.VI.1976 (Blacklight trap). 1♂, 3♀♀, 21 N Cabo Rojo 19–20.VI.1976 (R. E. Woodruff & E. E. Grissell) (Malaise trap). 8♂♂, 12♀♀, *Prov. Pedernales* (no locality) 19.VI.1976 (R. E. Woodruff). 1♀, S Side Lake Enriquillo IX.1938 (Darlington). 1♂, Cabrera 1.VIII.1978 (R. O. Schuster). 1♂, no locality 1976 (R. Devoe) (Blacklight trap). 1♂, S Domingo 8.X.1966 (L. H. Rolston). *Prov. Altagracia*: 1♂, Nisibon 9.VI.1976 (R. E. Woodruff) (Blacklight trap). 4♂♂, 3♀♀, same 8.VI.1976. 1♂, 2♀♀, same locality 8–10.VI.1976 (R. E. Woodruff & E. E. Grissell) (Malaise trap). *Prov. La Romana*: 3♂♂, 1♀, Higueral 15.VIII.1977 (R. E. Woodruff & E. Folch) (Blacklight trap). 1♂, same 18.VIII.1977. 2♀♀, La Romana 13.IX.1976 (E. Folch) (Blacklight trap). 1♀, same 18.IX.1976. *Prov. El Seibo*: 1♂, 5♀♀, Miches 9.VI.1976 (R. E. Woodruff) (Blacklight trap). *Prov. Santiago*: 1♂, Pedro Garcia 23.VIII.1967 (J. C. Schaffner) (at light). *Prov. La Vega*: 1♂, 8.VIII.1967 (L. H. Rolston). *Prov. Puerto Plata*: 1♂, 3♀♀, no locality (Hurst). 1♂, 22.VII.1967 (L. H. Rolston). HAITI: 7♂♂, 5♀♀, Diquini (W. M. Mann). 1♂, Port au Prince, Thor 10–12.X.1970 (J. E. Porter) (Blacklight trap). 1♂, Port au Prince (Mann). 1♀, Trou Caiman 15.XI.1934 (Darlington). 1♀, Petion. CUBA: 2♀♀, Guantanamo Bay Naval Base, Caravella Point 8–11.V.1972 (S. Calhoun) (Blacklight trap). 1♀, same 20.III.1972. 2♂♂, same 6.IX.1972. 2♂♂, same 11.IX.1972. 2♂♂, 2♀♀, same 2.X.1972. 1♀, same 30.X.1972. 1♂, same 31.X.1972. 2♂♂, 2♀♀, same 13.XI.1972. 1♀, same 15.XI.1972. 6♂♂, 16♀♀, Guantanamo Bay Naval Base, Kittery Beach Housing Area 8–11.V.1972 (S. Calhoun) (Blacklight trap). 8♂♂, 16♀♀, same 15–18.V.1972. 1♂, 3♀♀, same 24–27.VI.1972. 1♀, same 25.VII.1972. 2♀♀, same 21.VIII.1972. 2♀♀, Guantanamo Bay, Center Bargo 8.VIII.1972 (S. Calhoun) (Blacklight trap). 2♀♀, Guantanamo Bay 14.XI.1972 (S. Calhoun) (Blacklight trap). 1♂, 2♀♀, same 29.VIII.1972. 1♂, 1♀, same 14.XII.1972. 3♂♂, Guantanamo Bay 27.I.1970 (J.



Figs. 1-12. *Ozophora* spp. 1. *O. umbrosa*, "cup-like" sclerite of genital capsule, posterior view. 2. *O. levis*, "cup-like" sclerite of genital capsule, posterior view. 3. *O. pallidifemur*, "cup-like" sclerite of genital capsule, posterior view. 4. *O. umbrosa*, genital capsule, dorsal view. 5. *O. levis*, genital capsule, dorsal view. 6. *O. pallidifemur*, genital capsule, dorsal view. 7. *O. umbrosa*, genital capsule, lateral view. 8. *O. levis*, genital capsule, lateral view. 9. *O. pallidifemur*, genital capsule, lateral view. 10. *O. pallidifemur*, paramere. 11. *O. umbrosa*, sperm reservoir, dorsal view. 12. *O. umbrosa*, sperm reservoir, lateral view.

E. Tisdale) (Mosquito light trap). 1♀, same 12.III.1970. 1♂, same 20.III.1970. 1♂, 2♀♀, same 23.III.1970. 1♂, same 26.III.1970. 1♀, same 27.III.1970. 1♂, 2♀♀, 29.III.1970. 1♂, 1♀, same 30.III.1970. 1♂, 1♀, 31.III.1970. 1♀, same 1.IV.1970. 1♀, same 3.IV.1970. 1♀, same 12.IV.1970. 2♀♀, same 5.IV.1970. 1♂, 1♀, same 11.IV.1970. 1♂, same 20.IV.1970. 1♀, same 10.XI.1970. 2♀♀, same 14.XI.1970. 1♀, Guantanamo U.S.N. Base 8–19.II.1965 (Blacklight trap). 1♀, Habana-Marianao 15 m. 20.VII–20.VIII.1966 (F. Gregor). 1♀, Habana-Alamar 7–15.V.1965 (Jar. Prokop). PUERTO RICO: 16♂♂, 13♀♀, Rio Grande Co., 5 miles S Palmer 30.III–5.IV.1969 (Toby Schuh). 2♂♂, 1♀, Isabella Exp. Sta. 2.VII.1977 (R. E. Woodruff & A. E. Agostini) (Blacklight trap). 1♀, Guanica Insular Forest 6.XI.1953 (J. Maldonado Capriles). MONA I.: 1♂, 17–23.IV.1954 (J. Maldonado Capriles).

In American Museum of Natural History, University of California (Davis), Florida State Collection of Arthropods, National Museum of Natural History (U.S.N.M.), Texas A&M University, P. D. Ashlock, R. M. Baranowski, G. G. E. Scudder, and J. A. Slater collections.

*Additional material examined.* BAHAMAS: *Mayaguana I.* 65♂♂, 122♀♀, 26.VII–2.IX.1963 (C. Murvosh) (Blacklight trap). *Eleuthera I.* 1♂, 1♀, Rainbow Bay 18.XII.1975 (J. Wiley) (Blacklight trap). *Andros I.* 1♂, Forfar Field Stn. 10–15.VII.1983 (J. Peacock). *Berry I.* 1♀, Little Cay 1.V.1953 (E. B. Hayden & G. B. Rabb). *Great Abaco I.* 1♂, Marsh Harbour 6.V.1953 (E. B. Hayden & L. Giovannoli). 1♂, Fresh Creek 23.IV.1953 (at light) (E. B. Hayden & L. Giovannoli). *Turks and Caicos Isls.* 1♀, South Caicos I. 11.II.1953 (E. B. Hayden). 1♂, West Caicos I. 4.II.1953 (E. B. Hayden & L. Giovannoli).

*Discussion.* There is considerable color variation in this species. On Jamaica almost all specimens are dark gray or nearly black over the greater part of the body surface, the membrane never has a pale apex and the clavus is always deeply suffused. Frequently there are four pale maculae on the pronotum immediately behind the transverse impression and occasionally these are elongated to form short stripes but these are rarely so elongate as to subdivide the dark posterior portion of the pronotum. The first three antennal segments may occasionally be pale yellow although in such specimens the distal ends of the segments remain dark. Females tend to be darker than males, some females having the pale hemelytral macula reduced to a white spot adjacent to the corial apex. A few males are almost reddish-brown although they may be somewhat teneral.

This species may most readily be recognized by the distinct shape of the “cup-like sclerite” (Schaefer, 1977; Baranowski and Slater, 1983). The lobes of this sclerite are very broad and terminate in broad truncate darkly sclerotized distal ends that almost meet mesally (Fig. 1). Fortunately these sclerites are visible through the wall of the genital capsule and are the most reliable means of identification. Viewed laterally the caudo-dorsal end of the genital capsule is strongly but obtusely produced so that the posterior margin sweeps from the ventral to the dorsal surface in a concave arc (Fig. 7). This extension caudally of the capsule can also be observed in dorsal view (Fig. 4) where the posterior margin has a definite protrusion and the area of the dorsal opening in which the parameres lie is broadened mesally and trianguloid.

It is remarkable that this distinctive set of genital capsule features occurs in a species that is so variable in color and minor structural details.

The situation is most striking on Mayaguana Island in the Bahamas. I have ex-



amined an enormous series of *Ozophora* taken at a light trap from this island. The majority of specimens are of *umbrosa* which on the island tends to have the pale macula on the hemelytra fused to form an elongate pale stripe along the entire lateral area of the corium. In other words the transverse dark fascia that in specimens from the Greater Antilles reaches the lateral corial margin and separates the pale areas into discrete maculae is in Mayaguanan specimens reduced and does not attain the lateral corial margin thus creating a continuous pale stripe along the lateral portion of the corium. Occurring with *umbrosa* is a species of very similar external appearance but with a completely different genital and paramere shape. This latter species was recently described by Slater and Baranowski (1983) as *Ozophora levis* from Key Largo and the upper Bahamas. In that paper we discussed the presence of additional populations on Mayaguana and their relationships to those of the Greater Antilles.

In *levis* the arms of the "cup-like" sclerite are elongate and slender and broadly separated mesally (Fig. 2). Laterally the genital capsule ends in a sharp acute edge with the posterior margin not strongly concave (Fig. 8) and the portion of the dorsal opening on the capsule in which the parameres lie is not expanded (Fig. 5). The paramere has the inner projection elongate, tapering, and strongly down curved, the inner "tooth" broad and spatulate, the blade sinuate along the inner margin and the basal flange broad mesally, tapering anteriorly.

Externally, at least on Mayaguana, *umbrosa* may be distinguished from *levis* by having a pale first antennal segment (black in *levis*) and distinctly pale margins to the anterior pronotal lobe (in *levis* the lateral margins are dark and concolorous with the pronotal disc). In all specimens of *levis* examined the vittae on the posterior pronotal lobe that lie midway between the meson and margin are complete from the transverse impression to the posterior margin and the scutellum has a pair of pale spots. By contrast over 95% of the specimens of *umbrosa* from Mayaguana have the above pronotal vitta interrupted and most specimens lack a pair of pale scutellar spots. Specimens of *levis* from Key Largo and Eleuthera islands in the Bahamas are as above except that frequently the first antennal segment is pale. However, the color differences between Mayaguana specimens of *umbrosa* and those from the Greater Antilles is not true everywhere in the Bahamas. Specimens from Eleuthera and Andros islands are not appreciably different from those in the Greater Antilles. On the other hand Barber and Ashlock (1960) (under *atropicta*) discuss a series of 80 specimens from the Turks and Caicos islands and two from Fortuna Island as having only a narrow yellow marginal corial stripe. This is true of the few specimens I have examined as well.

Specimens of *umbrosa* from Hispaniola are very dark and usually lack pale pronotal margins, but do have a pale first antennal segment and like most populations from the Greater Antilles have conspicuous maculae rather than striping laterally on the hemelytra.

Specimens from Guantanamo Bay, Cuba approach some Bahaman material more closely than do specimens from the other islands of the Greater Antilles even to occasionally having the dark transverse fascia not reaching the lateral corial margin.

It is important to recognize that *levis* and *umbrosa* occur sympatrically on several islands of the Bahamas. On Eleuthera, for example, specimens of *umbrosa* are like those from the Greater Antilles (as are those from Andros) rather than of the Mayaguana type but typical specimens of *levis* also occur. Despite the usually reliable



color differences between the two species the genitalia should be examined for definitive identification.

#### MEASUREMENTS OF *OZOPHORA UMBROSA*

*Abbreviations.* N = number. LH = length head. WH = width head. IO = interocular space. AI = antennal segment I. AII = antennal segment II. AIII = antennal segment III. AIV = antennal segment IV. LI = labial segment I. LII = labial segment II. LIII = labial segment III. LIV = labial segment IV. LP = length pronotum. WP = width pronotum. LS = length scutellum. WS = width scutellum. ACL-ACO = apex clavus-apex corium. ACO-AAB = apex corium-apex abdomen. TL = total length.

#### *Ozophora umbrosa* Jamaica

	Males				Females			
	N	MEAN	SD	RANGE	N	MEAN	SD	RANGE
LH	15	0.74	.042	0.68-0.80	27	0.78	.047	0.72-0.88
WH	15	0.92	.047	0.84-1.00	27	0.98	.039	0.92-1.04
IO	15	0.39	.014	0.36-0.40	27	0.43	.019	0.40-0.48
A1	14	0.72	.035	0.64-0.76	27	0.71	.038	0.64-0.76
A2	14	1.53	.092	1.36-1.64	27	1.50	.078	1.36-1.64
A3	14	1.26	.075	1.12-1.36	27	1.23	.063	1.12-1.36
A4	11	1.50	.109	1.32-1.60	27	1.43	.059	1.36-1.60
L1	15	0.81	.038	0.72-0.84	27	0.85	.041	0.80-0.96
L2	15	0.75	.050	0.60-0.84	27	0.81	.041	0.76-0.92
L3	15	0.60	.038	0.52-0.64	27	0.65	.044	0.60-0.76
L4	15	0.38	.032	0.32-0.44	27	0.39	.029	0.60-0.76
LP	15	0.90	.060	0.80-1.00	27	0.97	.061	0.84-1.04
WP	15	1.34	.081	1.16-1.44	27	1.47	.087	1.32-1.60
LS	15	0.77	.058	0.64-0.84	27	0.84	.044	0.76-0.92
WS	15	0.67	.047	0.60-0.76	27	0.76	.043	0.64-0.84
ACL-ACO	15	1.12	.079	1.00-1.24	27	1.24	.066	1.12-1.36
ACO-AAB	15	0.79	.048	0.68-0.88	27	0.84	.059	0.72-1.00
TL	15	4.74	.301	4.16-5.20	27	5.30	.288	4.60-5.76

#### *Ozophora umbrosa* Puerto Rico

	Males				Females			
	N	MEAN	SD	RANGE	N	MEAN	SD	RANGE
LH	13	0.70	.026	0.64-0.72	13	0.73	.037	0.68-0.80
WH	13	0.88	.024	0.84-0.92	13	0.95	.030	0.92-1.00
IO	13	0.40	.011	0.36-0.40	13	0.43	.025	0.40-0.48
A1	13	0.64	.014	0.62-0.68	13	0.65	.019	0.64-0.68
A2	13	1.37	.037	1.32-1.44	13	1.36	.063	1.28-1.48
A3	13	1.13	.037	1.04-1.20	13	1.12	.045	1.04-1.20
A4	13	1.38	.042	1.28-1.44	13	1.34	.050	1.24-1.40
L1	13	0.77	.022	0.72-0.80	13	0.82	.031	0.76-0.88
L2	13	0.74	.020	0.72-0.76	13	0.78	.035	0.72-0.84

	Males				Females			
	N	MEAN	SD	RANGE	N	MEAN	SD	RANGE
L3	13	0.60	.029	0.56–0.64	13	0.63	.033	0.56–0.68
L4	13	0.37	.019	0.34–0.40	13	0.40	.038	0.36–0.48
LP	13	0.84	.021	0.82–0.88	13	0.90	.051	0.84–1.00
WP	13	1.29	.034	1.24–1.32	13	1.42	.060	1.36–1.56
LS	13	0.77	.035	0.68–0.76	13	0.80	.036	0.76–0.88
WS	13	0.65	.032	0.60–0.72	13	0.73	.039	0.64–0.80
ACL-ACO	13	1.13	.067	1.00–1.20	13	1.23	.090	1.00–1.32
ACO-AAB	13	0.79	.057	0.70–0.88	13	0.86	.074	0.76–1.04
TL	13	4.62	.103	4.48–4.80	13	4.99	.158	1.64–5.28

*Ozophora umbrosa* Haiti

	Males				Females			
	N	MEAN	SD	RANGE	N	MEAN	SD	RANGE
LH	7	0.78	.031	0.76–0.84	6	0.84	.062	0.80–0.96
WH	7	0.92	.015	0.92–0.96	6	1.01	.020	1.00–1.04
IO	7	0.41	.020	0.40–0.44	6	0.45	.020	0.44–0.48
A1	8	0.71	.028	0.68–0.76	6	0.72	.025	0.68–0.76
A2	8	1.60	.048	1.52–1.68	6	1.52	.046	1.44–1.56
A3	8	1.32	.040	1.28–1.40	6	1.28	.025	1.24–1.32
A4	8	1.48	.099	1.28–1.60	6	1.45	.048	1.40–1.52
L1	8	0.78	.037	0.72–0.84	6	0.85	.047	0.80–0.92
L2	8	0.78	.030	0.72–0.80	6	0.85	.039	0.80–0.88
L3	7	0.63	.030	0.60–0.68	5	0.69	.018	0.68–0.72
L4	7	0.38	.021	0.36–0.40	5	0.38	.022	0.36–0.40
LP	8	0.90	.036	0.84–0.96	6	1.00	.056	0.92–0.98
WP	8	1.41	.046	1.32–1.44	6	1.58	.055	1.52–1.68
LS	8	0.86	.037	0.80–0.92	6	0.94	.041	0.88–1.00
WS	8	0.75	.046	0.68–0.80	6	0.87	.070	0.76–0.92
ACL-ACO	8	1.22	.077	1.08–1.36	6	1.32	.084	1.24–1.44
ACO-AAB	7	0.91	.078	0.80–1.00	6	0.93	.078	0.84–1.04
TL	8	5.08	.260	4.72–5.36	6	5.44	.160	5.20–5.60

*Ozophora umbrosa* Dominican Republic

	Males				Females			
	N	MEAN	SD	RANGE	N	MEAN	SD	RANGE
LH	10	0.72	.053	0.62–0.80	10	0.75	.049	0.68–0.84
WH	10	0.91	.030	0.84–0.94	10	0.96	.030	0.92–1.00
IO	10	0.40	.013	0.38–0.42	10	0.44	.021	0.40–0.48
A1	10	0.58	.057	0.50–0.68	10	0.66	.062	0.58–0.72
A2	10	1.54	.098	1.42–1.66	8	1.46	.082	1.40–1.66
A3	9	1.27	.057	1.20–1.34	6	1.18	.052	1.10–1.26
A4	9	1.42	.059	1.34–1.50	6	1.30	.097	1.20–1.44
L1	10	0.66	.063	0.56–0.80	10	0.80	.058	0.68–0.88
L2	10	0.73	.030	0.70–0.78	10	0.82	.032	0.78–0.88

	Males				Females			
	N	MEAN	SD	RANGE	N	MEAN	SD	RANGE
L3	8	0.62	.041	0.58–0.68	7	0.65	.041	0.60–0.70
L4	9	0.37	.040	0.28–0.40	5	0.39	.027	0.36–0.42
LP	10	0.91	.044	0.84–0.98	10	0.99	.054	0.92–1.08
WP	10	1.38	.052	1.28–1.44	10	1.49	.051	1.44–1.60
LS	10	0.81	.040	0.74–0.88	10	0.87	.056	0.80–0.94
WS	10	0.70	.047	0.62–0.76	10	0.75	.045	0.68–0.80
ACL-ACO	10	1.14	.076	1.00–1.20	10	1.18	.118	0.90–1.32
ACO-AAB	10	0.85	.086	0.72–0.98	10	0.92	.142	0.76–1.16
TL	10	5.08	.019	4.80–5.28	10	5.30	.295	4.72–5.76

## DESCRIPTION OF NYMPHS

*Fifth instar* (Ocho Rios, Jamaica). Head, pronotum, wing pads, femora, tibiae, first, third, and distal half of fourth antennal segments and broad suffused area on abdominal terga two and three mesally dark chocolate brown. Mesothoracic wing pads with middle area of explanate margin and a pale macula laterally at middle adjacent to explanate margin yellow. Abdomen other than as above speckled with numerous pale yellow to white spots; area about dorsal abdominal scent glands dark brown rather quadrate, anterior scent gland sclerotization largest becoming successively smaller posteriorly; a suffused reddish brown area along abdominal sutures. Thoracic pleura chiefly dark chocolate brown but mesopleuron with a pale dash near dorsal margin and metapleuron with outer (=upper)  $\frac{1}{2}$  pale yellow with a longitudinal dark stripe through it. Coxae yellow mottled with dark brown. Second antennal segment dull yellowish brown becoming fuscous at distal end. Proximal one-half of fourth antennal segment with exception of extreme base white.

Head little declivent, tylus extending anteriorly midway along first antennal segment, epicranial stem very short. Length head 0.40, width across eyes 0.88; interocular space 0.46. Pronotum with anterior collar well delimited, lateral margins narrowly but acutely explanate, subquadrate. Length pronotum 0.70, width 1.12. Mesothoracic wing pads extending midway onto third abdominal tergum, moderately arcuate laterally. Length wing pads 1.40. Length abdomen 1.66. Forefemora rather slender, armed below with four or sometimes five small sharp spines. Labium extending well between metacoxae, first segment at most barely reaching base of head. Length labial segments I 0.70, II 0.74, III 0.42, IV 0.36. Length antennal segments I 0.48, II 1.08, III 1.00, IV 1.16. Total body length 3.80.

*Fourth instar* (as above). Similar in form and color to fifth instar. Second antennal segment completely yellowish brown. Tibiae pale, strikingly contrasting with dark femora. Pronotum with a pair of small yellow ovoid maculae on posterior margin midway between meson and humeri. Abdomen with dark area across third segment not extending anteriorly onto tergum two but reaching laterally to the forward extension of the Y-suture. Reddish markings on abdomen more strongly developed than in fifth instar. Metapleuron with a pale longitudinal stripe in dark area similar to but larger than that on mesopleuron. Length head 0.72, width 0.68; interocular space 0.38. Length pronotum 0.52, width 0.84. Length mesothoracic wing pads 0.60.

Length abdomen 1.52. Length labial segments I 0.50, II 0.40, III 0.46, IV 0.28. Length antennal segments I 0.32, II 0.74, III 0.70, IV 0.88. Total body length 3.32.

*Third instar* (as above). Very similar in form and color to instar four, area on either side of "Y"-suture between terga three and four broadly white forming a transverse white vittae across abdomen. Metapleuron also largely white with exception of a pair of transverse dark sclerotized areas thus giving insect an appearance of two transverse white stripes (possibly ant mimicry). Otherwise very similar in form and color to instar four. Length head 0.66, width 0.56; interocular space 0.30. Length pronotum 0.40, width 0.60. Length mesothoracic wing pads 0.26. Length abdomen 1.32. Length labial segments I 0.40, II 0.32, III 0.24, IV 0.24. Length antennal segments I 0.20, II 0.38, III 0.42, IV 0.27. Total body length 2.56.

#### BIOLOGY

The only biological information other than the frequency with which it comes to lights is from populations collected at the type locality three miles west of Ocho Rios on the north coast of Jamaica. Adults and nymphs were taken in litter below large specimens of *Ficus* sp. The longest series was a population from a habitat where figs were growing about the ruins of a large building. The fig trees were intricately entwined over the building ruins. They provided a heavily shaded habitat with little undergrowth, a relatively dry ground surface, the soil very friable and a moderate amount of leaf litter. This species runs very rapidly and when disturbed has a tendency to "flit" for a short distance rather than actually flying away. It was associated in this habitat with a species of the *pallescentis* complex and with *Ozophora laticephala*. Our other collection was in the same general area but below figs growing along the edge of a precipitous cliff above the beach. At both of these locations the insects were feeding upon the seeds of *Ficus*.

#### *Ozophora levis* Slater and Baranowski

Figs. 2, 5, 8

*Ozophora levis* Slater and Baranowski, 1983:433-435.

*Discussion.* The primary recognition features and differences from *umbrosa* new species are discussed above.

*Ozophora levis* was originally described from Key West, Key Largo, Big Pine Key, and Plantation Key, Florida. At the time of the original description we mentioned that specimens from Andros Island and Great Abaco Island were perhaps conspecific. This is not true since both of these specimens are referable to *Ozophora umbrosa* new species. However, as noted above *levis* does occur in the Bahamas where, at least, on some islands, it is sympatric with *umbrosa*. It will probably be found to occur widely in the Bahamas.

*Material examined.* BAHAMAS: 26♂♂, 39♀♀, Mayaguana I. 3.VIII-1.IX.1963 (C. Murvoch) (Blacklight trap). ABACO CAYS: 1♂, Allans Cay 9.V.1953 (E. B. Hayden & G. B. Rabb). ELEUTHERA I.: 2♀♀, Current Cut 26.XI.1964 (D. Dean) (on ship at light). 1♀, Powell Pt. 24.XI.1964 (D. Dean) (on ship at light). EGG I. 1♀, 1 mi. NW Eleuthera I. 26.XI.1964 (D. Dean) (on ship at light). GREAT ABACO I.: 1♂, Marsh Harbour 6.V.1953 (E. B. Hayden & L. Giovannoli).



*Ozophora archboldi*, new species

*Description.* General coloration chocolate brown. Head, anterior pronotal lobe, a broad median and two large lateral rays on posterior pronotal lobe, greater portion of scutellum, extreme lateral areas of corium, membrane and most of pleural and ventral surfaces dark brown. Testaceous to almost dull white as follows: apex of tylus; anterior pronotal collar; a longitudinal stripe through posterior pronotal lobe on either side of midline; pronotal humeri; a short "dash" on each raised "arm" of scutellar "Y"; apex of scutellum; cubital vein on clavus; claval suture; middle of radial vein of corium; explanate lateral corial margins; an elongate dash near inner angle of apical corial margin and veins of membrane. Legs, labium and first three antennal segments pale yellow. Apex of labium darker. Fourth antennal segment dark brown, lacking a strongly contrasting white proximal annulus. Hind femora slightly darker distally but lacking a conspicuous subdistal dark annulus. Body clothed above with numerous elongate upstanding hairs. Pronotal hemelytral punctures prominent but shallow and well separated from one another.

Head elongate, tylus reaching distal one-third of first antennal segment. Length head 0.80, width 0.95, interocular space 0.48. Lateral pronotal margins sinuate, tapering markedly from humeri to anterior margin; transverse impression complete. Length pronotum 0.88, width 1.75. Scutellum with a conspicuous "Y"-shaped elevation. Length scutellum 0.83, width 0.83. Hemelytra with lateral margins conspicuously explanate, slightly sinuate. Length claval commissure 0.86. Midline distance apex clavus-apex corium 1.28. Midline distance apex corium-apex membrane 0.86. Forefemur with three prominent spines below on distal one-half (a very small additional spine distad of these) and three elongate proximally placed hairs. Hind femur with two spines above and below near distal end. Labium very elongate, first segment extending posteriorly well beyond base of head, labium reaching fourth abdominal sternum. Length labial segments I 1.05, II 1.13, III 1.0, IV 0.43. Antennae elongate, slender, terete. Length antennal segments I 0.60, II 1.50, III 1.30, IV 1.60. Total body length 5.80.

*Holotype.* ♂, DOMINICA: Grand Savane, 3.II.1965 (J. F. G. & Thelma M. Clarke). In National Museum of Natural History (U.S.N.M.) No. 100059.

*Paratype.* ♀, DOMINICA: Clarke Hall 10-12.X.1966 (A. B. Gurney). In J. A. Slater collection.

*Discussion.* The paratype has more extensively developed pale areas on the corium than does the holotype as follows: posteriorly the pale coloration of the explanate corial margin extends broadly mesad to reach the radial vein thus forming a pale distal macula; at the level of the claval commissure there is an oblong pale patch extending mesad from the radial vein to almost reach the medius. The labium is slightly shorter in the paratype but still extends well onto the third abdominal sternum.

This species is closely related to *Ozophora levis* Slater and Baranowski. The color patterns, size and shape of the two species are very similar. However, *levis* lacks elongate upstanding hairs on the dorsal surface, usually has five prominent ventral forefemoral spines, lacks dorsal spines on the hind femora, has a much shorter labium that, at most, only slightly exceeds the metacoxae and has a conspicuous pale fourth antennal annulus.

The presence on Dominica of three taxa with elongate dorsal hairs (*longirostris* Slater, *quinquemaculata subtilis* Slater and *archboldi* n. sp.) each of which is related to a taxon that lacks them (*longirostris* to *rubrolinea*, *q. subtilis* to nominal *quinquemaculata* and *archboldi* to *levis*) suggests possible introgression on the wet islands of the Lesser Antilles. This is also suggested by the elongate labium that is found in both *longirostris* and *archboldi*.

*Ozophora pallidifemur pallidifemur* Scudder

Figs. 3, 6, 9, 10

*Ozophora pallidifemur pallidifemur* Scudder, 1958:148–149.

This is a predominantly dark chocolate brown to dark red brown species with contrastingly pale yellow legs. The first, second and third antennal segments also are for the most part pale yellow with the second segment narrowly and the third segment broadly infuscated distally. Antennal segment four is chocolate brown usually with a strongly contrasting white subbasal annulus. The membrane of the front wing lacks an apical pale macula and is uniformly fumose except for the pale veins.

The dorsal surface has upstanding hairs but they are sparse, short, easily abraded and can be readily overlooked. Scudder's original description and figure is otherwise satisfactory. The pronotal coloration is somewhat variable, some specimens have the lateral calloused margins concolorous with the dorsal surface, others having this area pale. The humeral angles are "notched" but often shallowly and obtusely so.

Scudder (1958) described a second species from the Caymans at the same time under the name *Ozophora fuscifemur*. He differentiated it from *pallidifemur* by: 1. its dark fuscous legs (instead of stramineous); 2. by lacking a distinct white fourth antennal annulus but having this area ferrugineous and relatively weakly differentiated from the dark distal portion of segment four; 3. lacking spines ventrally on the posterior femora; 4. shape and puncturation of the pronotum; and 5. armature of the forefemora.

I have examined paratypes of both taxa as well as the additional series from Grand Cayman listed below and do not believe that two species are involved. Both do have small spines ventrally on the posterior femora, the punctuation and shape of the pronotum is variable. Scudder's description of *pallidifemur* says the femur has "two long dark subapical spines with four pale hair-like spines proximally . . ." Whereas he says of *fuscifemur* "forefemora ventrally armed with three long and slender subapical spines" (both taxa have one or two minute spines distad of the large spines). It is true that both paratypes of *fuscifemur* before me have three "major" spines on each femur. But of 10 specimens of *pallidifemur* (including four paratypes) five specimens have three spines on each femur, four specimens have three spines on one leg and two on the other (one specimen has only one forefemur with two spines present). The number of "hair-spines" is variable as well as being difficult both to see and to differentiate from the remaining femoral vestiture. Thus, the forefemoral armature does not appear to be diagnostic.

The difference in leg color between the two taxa is striking and for the most part so is the color of the annulation of the fourth antennal segment. However, one female paratype of *pallidifemur* has a fourth antennal annulation as "ferrugineous" as that found in *fuscifemur*.

Scudder's illustrations of the hemelytral coloration of *fuscifemur* and *pallidifemur* show the former to have a completely dark clavus and no longitudinal pale striping on the corium. *O. pallidifemur* specimens do have a pale stripe on the elevated claval vein at least basally and generally more extreme pale corial striping although the differences are not so sharply differentiated as on Scudder's illustrations.

*Ozophora pallidifemur* was described from Grand Cayman and *O. fuscifemur* from Cayman Brac and Little Cayman. I have not seen specimens from Little Cayman but believe the most useful taxonomic conclusion is to recognize the darker specimens from Cayman Brac as a subspecies and I am therefore reducing *fuscifemur* to sub-specific status.

*Distribution.* Originally described from 29 females and 25 males from light traps at three localities on Grand Cayman Island. The nominal subspecies remains known only from there.

In addition to four paratypes I have examined four additional females from a light trap at Bodden Town ("trap O") and one male and one female from Prospect ("trap K"), all taken by M. E. C. Giglioli and in the P. D. Ashlock collection.

Dark specimens particularly of the ssp. *fuscifemur* resemble *umbrosa*. However, *fuscifemur* is readily distinguishable by the notched humeral angles and by details of the male genitalia. The arms of the "cup-like" sclerite (Fig. 3) are widely separated and somewhat like those of *O. levis* (Fig. 2) but are more evenly concave along the inner margins. The posterior margin of the genital capsule (Fig. 9) slopes evenly upward to terminate in an obtuse dorso-caudal angle which is quite unlike the acute sharp edged angle of *levis* (Fig. 8) or the produced edge of *umbrosa* (Fig. 7). The paramere is also distinctive from both *umbrosa* and *levis* despite the variability present in the former. In *pallidifemur* the shaft of the paramere (Fig. 10) is very thick, the inner "tooth" short, stout and does not sweep downward in an arc that occupies most of the inner surface and there is a small secondary tooth-like projection on the shaft near the basal connection.

*Ozophora pallidifemur fuscifemur* Scudder, **new status**

*Ozophora fuscifemur* Scudder: 1958:147-148.

As noted above *O. fuscifemur* may readily be distinguished from *O. pallidifemur* by the dark chocolate colored femora and usually by the completely dark clavus and yellowish brown rather white pale annulus on the fourth antennal segment. Scudder's (1958) dorsal view illustration shows the corium to be completely dark except for a large lateral area on the basal half, a subapical pale macula and a round pale spot near the inner angle of the corium. This may be true of the holotype, but on the two paratypes examined the pale lateral area along the basal half of the hemelytron is interrupted by dark interspaces. Scudder comments on the difference in the punctures on the head, pronotum and scutellum between *pallidifemur* and *fuscifemur*. The latter does appear to be somewhat more coarsely punctate on the pronotum.

*Distribution.* Originally described from Cayman Brac and Little Cayman. I have examined two paratypes from Cayman Brac.

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REVIEW OF THE GENUS *AGROECUS* DALLAS, WITH  
THE DESCRIPTION OF A NEW SPECIES  
(HEMIPTERA: PENTATOMIDAE)

D. A. RIDER AND L. H. ROLSTON

Department of Entomology, Louisiana Agricultural Experimental Station,  
Louisiana State University Agricultural Center,  
Baton Rouge, Louisiana 70803

**Abstract.**—A diagnosis and description for the genus *Agroecus* Dallas and diagnoses for all previously known species of the genus are given. *Agroecus reticulatus*, from Argentina, is described as new. A key to the species is provided. *Agroecus tenebricosus* Buckup, 1957, is placed in the synonymy of *A. griseus* Dallas, 1851, and lectotypes are designated for *A. griseus*, *A. ecuadoriensis* Jensen-Haarup, and *Euschistus lizerianus* Pennington.

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Dallas (1851) proposed the genus *Agroecus* to contain two species, *A. griseus* and *A. luridus*, which he also described at that time. Subsequently, *Pentatoma scabricorne* Herrich-Schäffer, 1844, was added to the genus by Lethierry and Severin (1893); Jensen-Haarup (1937) described *A. ecuadoriensis*; and Buckup (1957) described *A. tenebricosus* and *A. brevicornis*. Both Jensen-Haarup (1937) and Buckup (1957) provided a key to the species known to them. Rolston (1982) transferred *A. luridus* Dallas, 1851 (p. 200), to *Euschistus* Dallas, 1851, thereby creating a secondary homonym with *E. tristigmus luridus* Dallas, 1851, originally described as *E. luridus* (p. 207). Thomas (1983) eliminated the homonymy by selecting *E. aceratos* Berg, 1894, an available junior synonym of *A. luridus*, as the valid name. More recently, Rolston (1985) transferred *Euschistus lizerianus* Pennington, 1922, to *Agroecus*.

A diagnosis and description of the genus, a description of a new species from Argentina, diagnoses for the other species, and a key to species are given here. *Agroecus tenebricosus* Buckup, 1957, is placed in the synonymy of *A. griseus* Dallas, 1851. Lectotypes are designated for *A. griseus* Dallas, *A. ecuadoriensis* Jensen-Haarup, and *Euschistus lizerianus* Pennington. When label data are cited in the text, the letters in parentheses represent separate labels with (a) being closest to the specimen on the pin.

*Agroecus* Dallas, 1851

*Agroecus* Dallas, 1851:193, 199; Stål, 1867:528; Walker, 1867:243; Stål, 1872:23; Distant, 1890:329; Lethierry and Severin, 1893:126; Kirkaldy, 1909:63; Jensen-Haarup, 1937:170-171; Buckup, 1957:7-8; Rolston, 1974:4; Froeschner, 1981:68; Rolston and McDonald, 1984:71.

**Type species.** *Agroecus griseus* Dallas, 1851 (by subsequent designation, Kirkaldy, 1909:XXIX).

**Diagnosis.** Third (second visible) abdominal sternite lacking mesial tubercle or spine. Ostiolar rugae short, auriculate. Inferior surface of each femur with two parallel

rows of low tubercles, each tubercle bearing a seta. Width of scutellum at distal end of frena about  $\frac{3}{5}$  of basal width. Each corium with several longitudinal, impunctate bands; basal  $\frac{1}{4}$  of costal margin slightly tuberculate. Anterolateral margin of pronotum denticulate. Basal plates strongly convex in profile (Figs. 26–31).

*Description.* Ovate to broadly ovate; dorsal surface slightly convex; ventral surface strongly convex. Dorsal surface of head flat to slightly convex; juga and tylus usually subequal in length (juga much longer than tylus in *A. ecuadoriensis*). Each antenna 5-segmented; first segment nearly reaching or slightly surpassing apex of tylus. Anterolateral margin of pronotum concave or straight, denticulate. Scutellum broadly rounded apically; width at distal end of frena about  $\frac{3}{5}$  basal width. Each corium with several longitudinal impunctate lines; basal  $\frac{1}{4}$  of costal margin slightly tuberculate; veins on hemelytral membrane usually parallel (reticulate in *A. reticulatus*, n. sp.). First rostral segment extending to or slightly beyond posterior margin of bucculae; apex of second segment reaching beyond middle of mesosternum; apex of fourth segment reaching between metacoxae. Metasternum weakly sulcate; mesosternum weakly carinate; prosternum flat. Each ostiolar ruga short, auriculate. Each femur armed on inferior surface with two rows of low tubercles, each tubercle bearing a seta. Tarsi 3-segmented. Third (second visible) abdominal sternite without mesial spine or tubercle. Posterior margin of pygophore from ventral view straight or rounded with a mesial V-shaped emargination. Parameres with apical one-third bent anterolaterally and with a concave cup basally. Thecal appendages present. Basal plates strongly convex from lateral view; mesial margins straight or slightly concave from caudoventral view; apices slightly to moderately produced; posterior margin entire, not tuberculate. Surface of each ninth paratergite concave.

*Comments.* Species of *Agroecus* occur throughout South America with one species, *A. griseus*, reported from Panama by Distant (1890). As the synonymy of some species of *Agroecus* suggests, the genus is similar to *Euschistus* in many respects. The armed femora, broadly rounded apex of the scutellum, and the impunctate longitudinal lines on the corium are diagnostic.

#### KEY TO SPECIES OF *AGROECUS*

1. Veins on hemelytral membrane reticulate; anteocular process strongly produced, spinose (Fig. 1) (Argentina) ..... *reticulatus* n. sp.
- Veins on hemelytral membrane parallel; anteocular process weakly produced or absent (Figs. 2–4) ..... 2
- 2(1). Juga distinctly longer than tylus (Fig. 2) (Bolivia, Ecuador, Peru) ..... *ecuadoriensis* Jensen-Haarup
- Juga and tylus subequal in length (Figs. 3–4), or if juga appreciably exceeding tylus in length, then a sparsely punctate transhumeral fascia present ..... 3
- 3(2). Denticles along anterolateral margin of pronotum widely spaced, space between most denticles more than twice basal diameter of largest denticle (Fig. 7); anterolateral margin of pronotum always concave ..... 4
- Denticles along anterolateral margin of pronotum narrowly spaced, space between most denticles less than twice basal diameter of largest denticle (Fig. 8); anterolateral margin of pronotum straight or concave ..... 5
- 4(3). Transhumeral fascia clearly defined, impunctate or nearly so (Fig. 7); space between pronotal denticles usually 4–5 times basal diameter of largest denticle (Brazil) .... *scabricornis* (Herrich-Schäffer)

- Transhumeral fascia obscure, punctate; space between pronotal denticles usually 2–3 times basal diameter of largest denticle (Brazil) ..... *lizerianus* (Pennington)
- 5(3). Anterolateral pronotal margin distinctly concave (Brazil) ..... *brevicornis* Buckup
- Anterolateral pronotal margin straight or substraight (Fig. 8) (Panama southward throughout South America to northern Argentina) ..... *griseus* Dallas

***Agroecus reticulatus*, new species**

Figs. 1, 5, 20, 26; Map, Fig. 32

*Description.* Overall color dark brown; punctures shallow, fuscous. Length 9.0, width across humeri 5.5 mm.

Head generally flat dorsally, tylus and vertex slightly elevated, jugal margins slightly and broadly reflexed. Color brown; punctures fuscous, slightly coarser and darker on vertex. Apex of head broadly rounded; jugal margins subparallel for middle  $\frac{1}{3}$  of distance from eyes to apex; juga and tylus subequal in length. Antecular process distinctly produced, spinose (Fig. 1). Length of head from apex to posterior margin of ocelli 1.6, width across eyes 2.3 mm. Each antenna pale brown, segments 1 and 5 slightly darker; length of segments 1–5 about 0.6, 0.9, 0.9, 0.9, 1.3 mm.

Pronotum brown, except a mesial longitudinal impunctate line anteriorly and some interstitial rugae, pale. Punctures fuscous, coarser and darker posteriorly than anteriorly. Anterolateral margin nearly straight, denticulate, with denticle on anterolateral corner distinctly bifid; space between most denticles subequal to basal width of largest denticle (Fig. 5). Anterior angle of each humerus broadly rounded, not produced beyond corial base; several small denticles between anterior angle and base of corium. Pronotal length 2.1, width 5.5 mm.

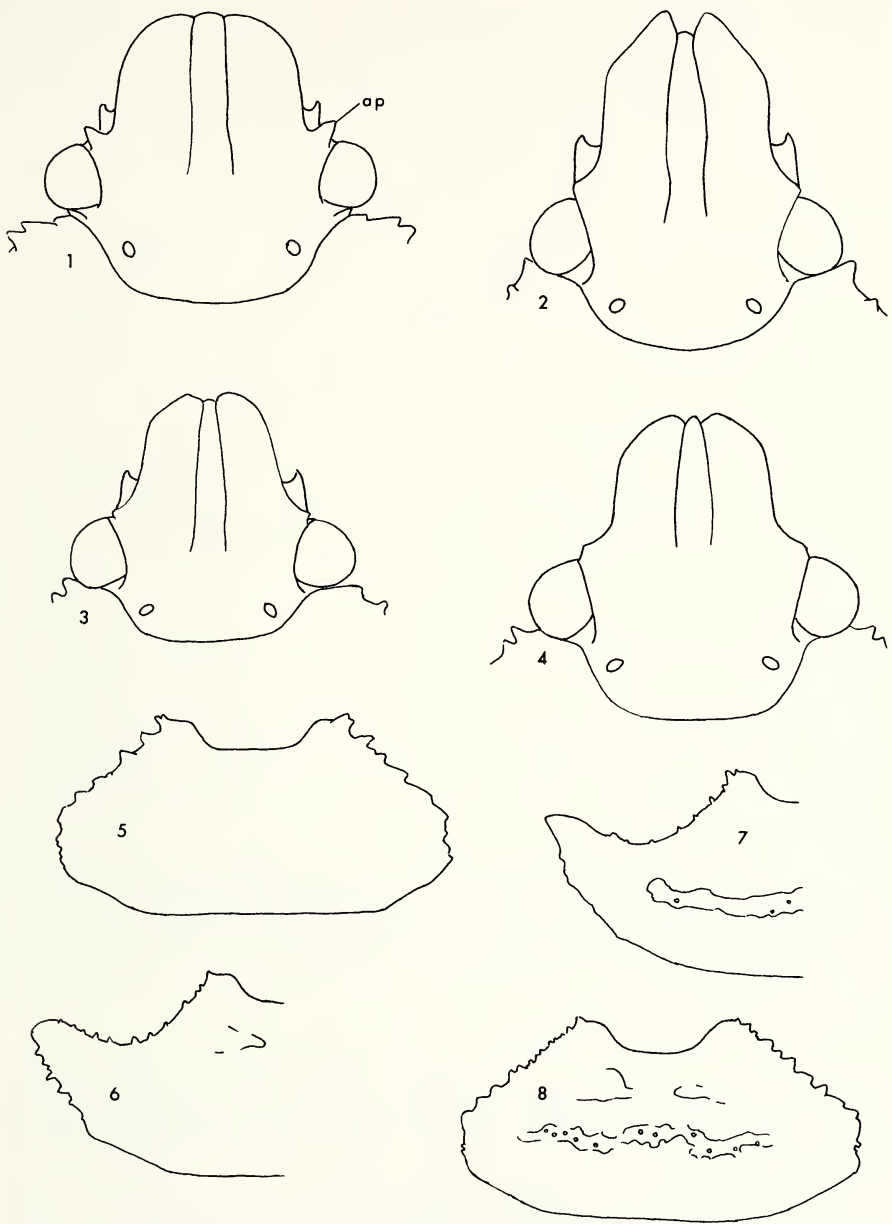
Scutellum brown; 5 small, equally spaced, pale, impunctate or sparsely punctate areas along basal margin; basal angles foveate, black; punctures fuscous. Anterior margin of scutellum evenly convex. Scutellum slightly longer than broad, length 3.9, width 3.6 mm; scutellar tongue wider than long, length 2.1, width 2.5 mm.

Corium brown; an irregular, narrow, impunctate area along outer margin of endocorium furcating distally, and a straight, impunctate line on endocorium along claval suture, both subcalloused. Apex of corium barely surpassing apex of scutellum, reaching posteromedial angle of fifth connexival segment. Posterior margin of corium nearly straight. Veins of hemelytral membrane reticulate. Connexivum widely exposed; punctures brown, fuscous along posterior margin and near each anterolateral angle of each segment.

Venter brown, prosternum and mesosternum black; punctures fuscous to black, paler near lateral margins of abdomen; spiracles black; abdominal venter mottled brown and fuscous, anterolateral angles fuscous. Abdominal segments, legs, and ventral surface of rostrum covered with numerous hairs, particularly long on legs. Legs brown, tarsal segments and apical half of each tibia pale brown. Rostrum brown, reaching posterior margin of metacoxae, length of segments 2–4 about 1.6, 0.6, 0.6 mm.

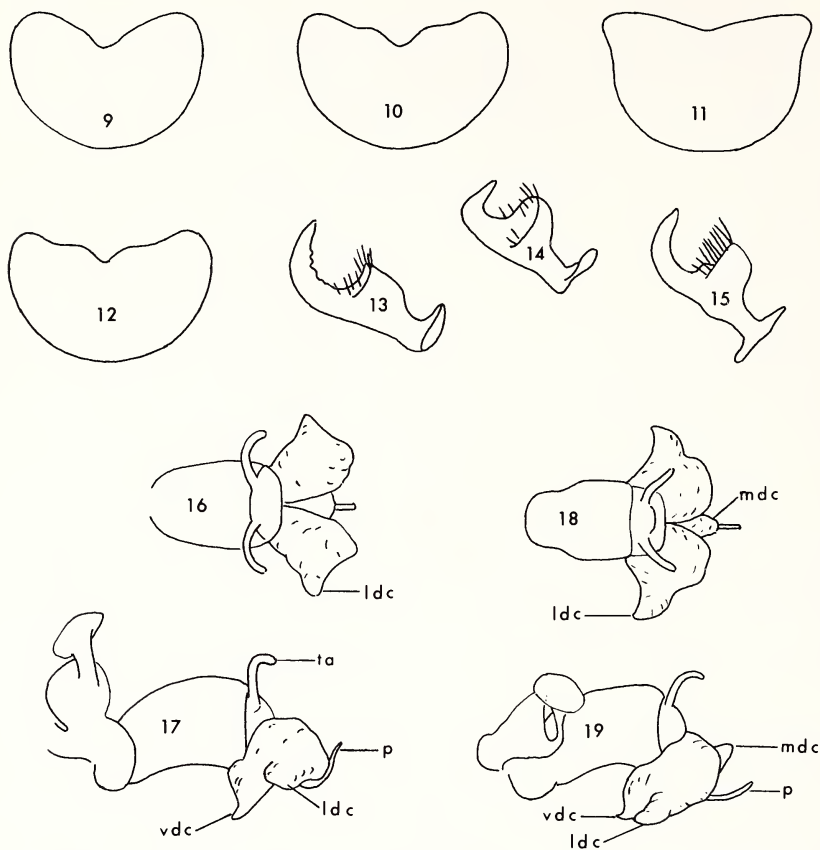
Mesial margin of each basal plate straight from caudoventral view, posterior margin of each basal plate concave (Figs. 20, 26). Male unknown.

*Type.* Holotype ♀, labeled "R. A. Tucumán, Siambón XII.944, Olea Col." The holotype specimen is missing the following body parts: entire left metathoracic leg, all tarsal segments on both prothoracic legs, and segments 2–5 of one antenna.



Figs. 1-8. Figs. 1-4. Head. 1. *A. reticulatus*. 2. *A. ecuadoriensis*. 3. *A. brevicornis*. 4. *A. griseus*. Figs. 5-8. Pronotum. 5. *A. reticulatus*. 6. *A. ecuadoriensis*. 7. *A. scabricornis*. 8. *A. griseus*. Symbol: ap, anteocular process.





Figs. 9-19. Figs. 9-12. Pygophore, caudal view. 9. *A. ecuadoriensis*. 10. *A. scabricornis*. 11. *A. brevicornis*. 12. *A. griseus*. Figs. 13-15. Right paramere. 13. *A. ecuadoriensis*. 14. *A. griseus*. 15. *A. scabricornis*. Figs. 16-19. Theca and related structures. 16. *A. ecuadoriensis*, dorsal view. 17. *A. ecuadoriensis*, lateral view. 18. *A. griseus*, dorsal view. 19. *A. griseus*, lateral view. Symbols: ldc, lateral diverticulum; mdc, median diverticulum; p, penisfilum; ta, thecal appendage; vdc, ventral diverticulum.

Segments 2-5 of the other antenna are glued to a card below the specimen. The holotype is deposited in the Fundacion Miguel Lillo, Instituto de Zoologia, Tucumán, Argentina. No paratypes.

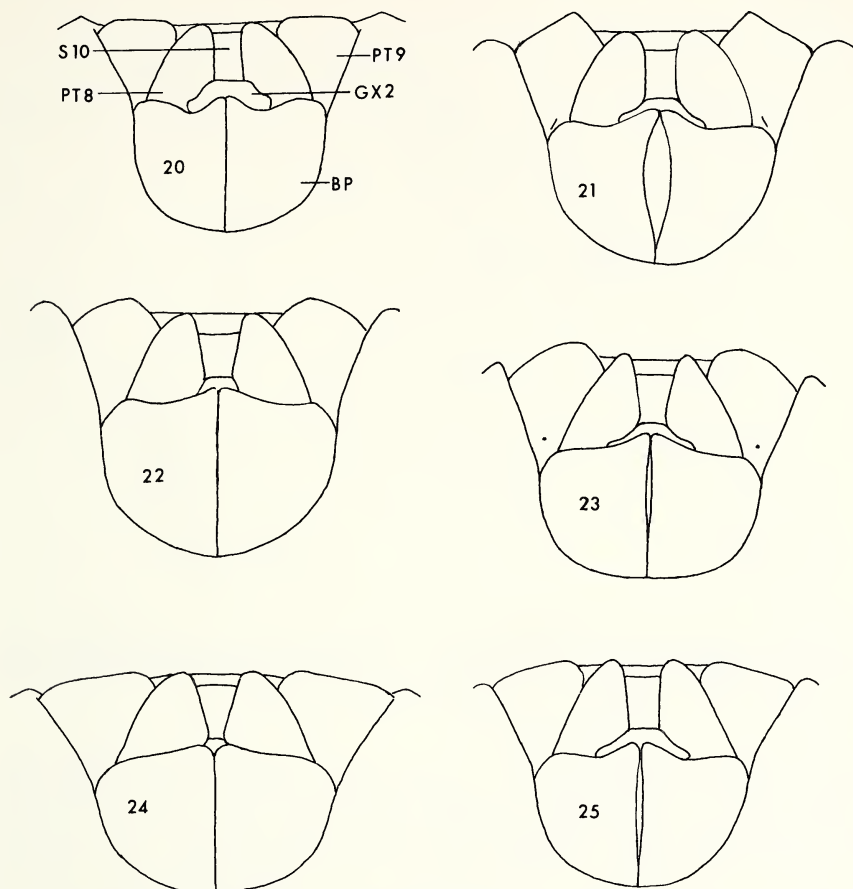
*Distribution.* Argentina (Tucumán) (Fig. 32).

*Comments.* This is a very distinctive species. It can be separated from all other congeners by the prominent anteocular processes and the reticulate veins on the hemelytral membranes.

*Agroeus ecuadoriensis* Jensen-Haarup, 1937

Figs. 2, 6, 9, 13, 16, 17, 21, 27; Map, Fig. 32

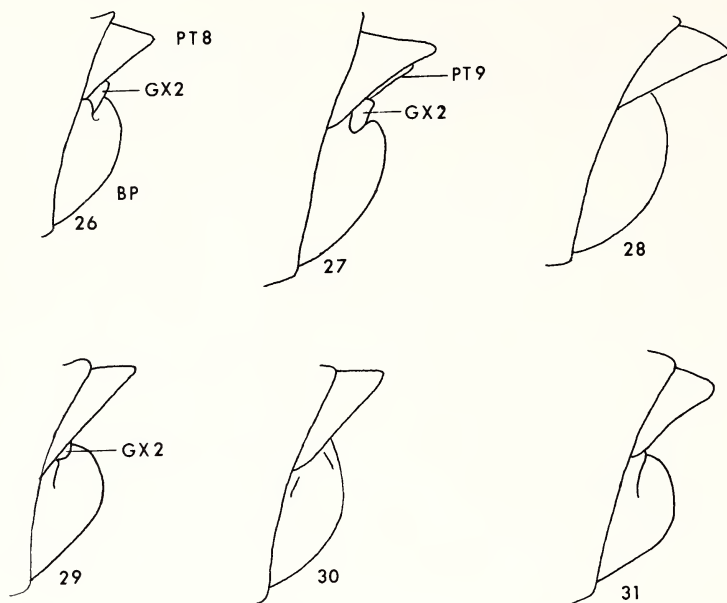
*Agroeus ecuadoriensis* Jensen-Haarup, 1937:171; Pirán, 1956:33; Buckup, 1957:16-17; Froeschner, 1981:68.



Figs. 20–25. Genital plates, caudoventral view. 20. *A. reticulatus*. 21. *A. ecuadoriensis*. 22. *A. scabricornis*. 23. *A. lizerianus*. 24. *A. brevicornis*. 25. *A. griseus*. Symbols: BP, basal plate; GX2, second gonocoxae; PT8, eighth paratergite; PT9, ninth paratergite; S10, tenth sternite.

**Diagnosis.** Jugs apically acute, longer than tylus by more than the width of tylus, not convergent before tylus; jugal margins subparallel for middle third of distance from eyes to apex of head (Fig. 2). Antecular process weakly produced or absent. Anterolateral margin of pronotum distinctly concave; most denticles small, spaced less than twice the basal diameter of largest denticle. Humeral angles strongly produced anterolaterad (Fig. 6). No clearly defined impunctate transhumeral fascia. Veins of hemelytral membrane parallel. Posterior margin of pygophore evenly V-shaped from caudal view (Fig. 9). Paramere with internal surface of bend denticulate (Fig. 13). Theca as in Figures 16 and 17. Mesial margins of each basal plate distinctly concave from caudoventral view (Fig. 21). Genital plates from lateral view as in Figure 27.

**Types.** Jensen-Haarup (1937) described *A. ecuadoriensis* from one male and two female specimens, but he did not designate a holotype or paratypes. Only two of the original three specimens were located. The female specimen labeled (a) “Type” (b)



Figs. 26–31. Genital plates, lateral view. 26. *A. reticulatus*. 27. *A. ecuadoriensis*. 28. *A. scabricornis*. 29. *A. lizerianus*. 30. *A. brevicornis*. 31. *A. griseus*. Symbols: BP, basal plate; GX2, second gonocoxae; PT8, eighth paratergite; PT9, ninth paratergite.

“Santa Inez, (Ecuador), R. Haensch S.” (c) “Ecuador, Rich Haensch, vend. 30.IV.1903” (d) “Type, Coll. J = Hrp.” (e) “A. C. Jensen-Haarup determ. 1931–1932” (f) “*Agroecus ecuadoriensis* J-Hrp, Jensen Haarup det.” (g) “*Agroecus ecuador.*” (h) “Holotype” is designated as the lectotype. The male specimen labeled (a) “Type” (b) “Type, Coll J = Hrp.” (c) “Santa Inez, (Ecuador), R. Haensch S.” (d) “Ecuador, Rich. Haensch, vend. 30.IV.1903” (e) “A. C. Jensen-Haarup determ. 1931–32” (f) “*Agroecus ecuadoriensis* J-Hrp, Jensen-Haarup det.” is designated as the paralectotype. The lectotype and paralectotype were examined. The types are housed in the Zoologisches Institut und Zoologisches Museum, Hamburg, Germany.

**Distribution.** Bolivia (Cochabamba, La Paz), Ecuador (Santa Inez), Peru (Cuzco) (Fig. 32).

**Specimens examined.** 9 specimens. **BOLIVIA:** Songo (♂); Cochabamba, Chapare, Palmar (2♀♀); La Paz, Yungas de la Paz (2♀♀). **ECUADOR:** Santa Inez (♀ ♂). **PERU:** Cuzco, Machupicchu Pueblo (♀), Santa Isabel, Valley of River Ccosnipata (♂).

**Comments.** This species is easily recognized by the long juga, which are longer than the tylus by at least the width of the tylus. The male and female genitalia are also distinctive.

*Agroecus scabricornis* (Herrich-Schäffer, 1844)

Figs. 7, 10, 15, 22, 28; Map, Fig. 32

*Pentatoma scabricorne* Herrich-Schäffer, 1844:98–99, fig. 762; Stål, 1872:65.

*Euschistus scabricornis*: Stål, 1860:19; Walker, 1867:248.



Fig. 32. Known distribution of *A. brevicornis* (○), *A. ecuadoriensis* (⊛), *A. griseus* (●), *A. lizerianus* (◐), *A. reticulatus* (◇), *A. scabricornis* (■) (Panama record from literature).



*Lycipta scabricornis*: Stål, 1862:58.

*Agroecus scabricornis*: Lethierry and Severin, 1893:126; Kirkaldy, 1909:63; Jensen-Haarup, 1937:171; Buckup, 1957:9, 15–16, pl. 1 fig. 4, pl. 2 fig. 4; Buckup, 1961:9; Rolston, 1982:281.

*Diagnosis.* Jugal slightly longer than tylus; jugal margins subparallel for middle one-third of distance from eyes to apex of head. Anteocular process weakly produced or absent. Anterolateral margin of pronotum distinctly concave; denticles small, space between denticles usually 4–5 times basal diameter of largest denticle (Fig. 7). Humeral angle acute, nearly spinose, strongly produced anterolaterad. A clearly defined, raised, transhumeral, impunctate fascia present. Veins of hemelytral membrane parallel. Posterior margin of pygophore sinuously V-shaped from caudal view (Fig. 10). Paramere as in Figure 15. Mesial margin of each basal plate straight from caudoventral view (Fig. 22). Genital plates from lateral view as in Figure 28.

*Type.* Herrich-Schäffer (1844) described *A. scabricornis* from one female specimen. The specimen is apparently no longer in existence, but his description and figure are adequate to fix this distinctive species, thus no neotype is designated.

*Distribution.* Brazil (Santa Catarina, Rio de Janeiro, São Paulo, Paraná) (Fig. 32).

*Specimens examined.* 11 specimens. **BRAZIL:** *Paraná*, Guartara (♀); *Rio de Janeiro*, Guanabera (♀), Repressa Rio Grande (2♂♂), Silva Jardim (♀); *Santa Catarina*, Corupá (♀), Nova Teutônia (2♀♀ ♂), Rio Natal (♀); *São Paulo*, Caraguatatuba (♀).

*Comments.* This species can be separated from all other congeners by the clearly defined, impunctate, transhumeral fascia and by the widely spaced pronotal denticles.

*Agroecus lizerianus* (Pennington, 1922)

Figs. 23, 29; Map, Fig. 32

*Euschistus lizerianus* Pennington, 1922:316–317.

*Agroecus lizerianus*: Rolston, 1985:353.

*Diagnosis.* Jugal and tylus subequal in length; jugal margins subparallel for middle one-third of distance from eyes to apex of head. Anteocular process weakly produced or absent. Anterolateral pronotal margin distinctly concave; space between most denticles 2–3 times basal diameter of largest denticle. Humeral angle acute, moderately produced anterolaterad. No clearly defined impunctate transhumeral fascia. Veins of hemelytral membrane parallel. Mesial margin of each basal plate nearly straight from caudoventral view (Fig. 23). Genital plates from lateral view as in Figure 29. Male unknown.

*Type.* Pennington (1922) probably described *A. lizerianus* from a single female specimen, but it cannot be determined for certain that he had only one specimen. The female specimen labeled (a) “I. Santiago I 1918” (b) “Typus” (c) “C. J. Drake Coll.” (d) “M. S. Pennington, *Euschistus lizerianus* n. sp. 1922” is designated as the lectotype. The lectotype, which is housed in the National Museum of Natural History, Washington, D.C., was examined.

*Distribution.* Brazil (Santa Catarina), Argentina (Buenos Aires) (Fig. 32).

*Specimens examined.* 4 specimens. **ARGENTINA:** *Buenos Aires*, Isla Santiago (♀). **BRAZIL:** *Santa Catarina*, Nova Teutônia (3♀♀).

*Comments.* *Agroecus lizerianus* most closely resembles *A. brevicornis*, but the two

can be separated by the more widely spaced pronotal denticles in *A. lizerianus*, and by the jugal margins, which are not parallel in *A. brevicornis* as they usually are in *A. lizerianus*.

*Agroecus brevicornis* Buckup, 1957

Figs. 3, 11, 24, 30; Map, Fig. 32

*Agroecus brevicornis* Buckup, 1957:8, 13–15, pl. 1 fig. 3, pl. 2 fig. 3; Buckup, 1961:9; Pirán, 1966:86.

*Diagnosis.* Juga and tylus subequal in length or juga slightly longer than tylus; jugal margins not parallel (Fig. 3). Antecular process weakly produced or absent. Anterolateral margin of pronotum concave; space between most denticles less than twice the basal diameter of largest denticle. Humeral angle acute, produced anterolaterad. No clearly defined, impunctate, transhumeral fascia. Veins of hemelytral membrane parallel. Posterior margin of pygophore weakly V-shaped from caudal view (Fig. 11). Mesial margin of each basal plate straight from caudoventral view (Fig. 24). Genital plates from lateral view as in Figure 30.

*Type.* Buckup (1957) described *A. brevicornis* from three female and two male specimens. The female holotype and male allotype were examined. The types are housed in the Museu de Ciências Naturais, Pôrto Alegre, Brazil.

*Distribution.* Brazil (Paraná, Santa Catarina) (Fig. 32).

*Specimens examined.* 4 specimens. **BRAZIL:** Paraná, Curitiba (♀), Rio Negro (♂); Santa Catarina, Nova Teutônia (2♀♀).

*Comments.* The non-parallel jugal margins occur only in this species and, rarely, in *A. griseus*. *Agroecus brevicornis* can be separated from *A. griseus* by the concave anterolateral pronotal margins, which are straight in *A. griseus*.

*Agroecus griseus* Dallas, 1851

Figs. 4, 8, 12, 14, 18, 19, 25, 31; Map, Fig. 32

*Agroecus griseus* Dallas, 1851:199, pl. VII fig. 4; Walker, 1867:243; Stål, 1872:23; Distant, 1890:329, pl. 31 fig. 8; Lethierry and Severin, 1893:126; Kirkaldy, 1909:63; Jensen-Haarup, 1937:171; Buckup, 1957:8, 9–11, pl. 1 fig. 1, pl. 2 fig. 1; Buckup, 1961:9.

*Agroecus tenebricosus* Buckup, 1957:8, 11–13, pl. 1 fig. 2, pl. 2 fig. 2. **NEW SYNONYMY.**

*Diagnosis.* Juga and tylus subequal in length; jugal margins subparallel for middle one-third of distance from eyes to apex of head. Antecular process weakly produced or absent (Fig. 4). Anterolateral margin of pronotum straight or substraight; space between most denticles usually less than twice basal diameter of largest denticle (Fig. 8). Humeral angle usually rounded, rarely somewhat angular, at most only slightly produced laterad. Transhumeral fascia somewhat irregular, with scattered punctures. Veins of hemelytral membrane parallel. Posterior margin of pygophore sinuously V-shaped from caudal view (Fig. 12). Paramere as in Figure 14. Theca as in Figures 18 and 19. Mesial margin of each basal plate straight or weakly concave from caudoventral view (Fig. 25). Genital plates from lateral view as in Figure 31.

*Types.* Dallas (1851) described *A. griseus* from 1 male and 2 female specimens

from Brazil and 1 female specimen from British Guiana, but he did not designate a holotype or paratypes. The male specimen labeled (a) "Brazil" (upper surface), "45 67" (lower surface) (b) "b" (lower surface) (c) "griseus identified by Dallas" is designated as the lectotype. The remaining 3 female specimens are designated as paralectotypes. They have the following label data: (a) "Type" (b) "Agroecus griseus, Dallas (*Type*.)" (c) "B. Guiana" (upper surface), "44 85" (lower surface) (d) "a" (lower surface) (e) BRIT. MUS. TYPE No. HEM. 1024"; (a) "Brazil" (upper surface), "45 67" (lower surface) (b) "b" (lower surface) (c) "Agroecus griseus Walker's catal."; and (a) "Brazil" (upper surface), "45 67" (lower surface) (b) "b" (lower surface) (c) "1. Agraecus griseus." All five specimens, which are housed in the British Museum (Natural History), London, were examined. The holotype specimen of *A. tenebricosus* Buckup was also examined, and is housed in the Museu de Ciências Naturais, Pôrto Alegre, Brazil.

*Distribution.* Panama southward throughout South America to northern Argentina (Fig. 32).

*Specimens examined.* 76 specimens. **ARGENTINA:** Misiones, Delicia (♀), Eldorado (♀), Let (♂). **BOLIVIA:** La Paz, Yungas de la Paz (♀). **BRAZIL:** Brazil (2♀♀ ♂); Chapada (♀); Amazonas, Rio Caiary-Uaupés (♂); Bahia, Brasília (♀), Nova Conquista (♂); Mato Grosso, Barra de Tapirape (♀), 10°25'S, 59°28'W (♀ 2♂), Xavantina (♀); Minas Gerais, Vicosá (♀); Pará (5♀♀ ♂), Jacaréncanga (♀), Santarém (♀ 3♂); Pernambuco, Bonito (♂); Rio de Janeiro (♂), Mendes (♂); Santa Catarina, Nova Teutônia (15♀♀ 11♂); São Paulo, Piracicaba (♀ ♂). **BRITISH GUIANA:** British Guiana (♀); **COLOMBIA:** César, El Roncon about 10–12 km E Becerril Rio San Juan (♂). **FRENCH GUIANA:** Cayenne (♀). **PARAGUAY:** Concepción, Horqueta, 45 miles E Paraguay Riv. (3♀♀ ♂); Cordillera, Inst. Agro. Nac., Caacupé (♀ ♂), San Bernardino (♂). **PERU:** Huánuco, Tingo María (3♀♀); Junín, Estancia Naranjal San Ramón (♀), Satipo (2♂). **VENEZUELA:** Aragua, Rancho Grande (♂).

*Comments.* *Agroecus griseus* can be separated from all congeners except *A. reticulatus* by the straight anterolateral margin of the pronotum. It can be separated from *A. reticulatus* by the parallel veins on the hemelytral membrane, and by the weakly produced or absent anteocular process. The holotype of *A. tenebricosus* has the straight anterolateral pronotal margin and the weakly produced anteocular process characteristic of *A. griseus*. It does not differ from *A. griseus* in any significant manner.

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**LIFE HISTORY OF THE ISSID PLANTHOPPER  
*THIONIA ELLIPTICA* (HOMOPTERA: FULGOROIDEA) WITH  
DESCRIPTION OF A NEW *THIONIA* SPECIES FROM TEXAS**

A. G. WHEELER, JR.<sup>1</sup> AND STEPHEN W. WILSON<sup>2</sup>

<sup>1</sup>Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110, and <sup>2</sup>Department of Biology, Central Missouri State University, Warrensburg, Missouri 64093 USA

*Abstract.*—The life history of *Thionia elliptica* (Germer) in Pennsylvania is outlined and the immatures described and illustrated. This univoltine issid has five nymphal instars, feeds on scrub oak (*Quercus ilicifolia* Wang.), has been collected from blackjack oak (*Quercus marilandica* Muenchh.), and apparently overwinters as eggs. Specimens are recorded from Arkansas, Kentucky, Missouri, North Carolina, and Pennsylvania. Specimens from Texas described by Doering as *T. elliptica* differ in the morphology of the aedeagus and, thus, are described as the new species *T. obrienae* Wilson. On the basis of adult and nymphal morphology, it is suggested that acanaloniid planthoppers, generally accorded family status by North American workers, be treated as a subfamily (Acanaloniinae) of the Issidae following Fennah (1954).

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The genus *Thionia* includes 71 species distributed throughout the New World (Fennah, 1965; Metcalf, 1958). Doering (1938) monographed the seven species found north of Mexico. Except for occasional references to food plants nothing is known of the biology of any of the species.

While collecting insects in eastern Pennsylvania, a number of specimens of *Thionia* were found on their host plant, scrub oak (*Quercus ilicifolia* Wang.). Upon detailed examination, these specimens were determined to be *T. elliptica* (Germer) nec. Doering; specimens described by Doering (1938) represent an unnamed species.

The present paper includes a study of seasonal history and descriptions of the male and female, eggs, and the five nymphal instars of *T. elliptica*; description of the new species *T. obrienae* Wilson; and comments on the higher classification of issids and acanaloniids.

**MATERIALS AND METHODS**

*Field study.* *T. elliptica* was first collected in 1984 along Rt. 81 about 5 mi south of Frackville (Schuylkill Co.), Pennsylvania. The site, a moist pitch pine-scrub oak barrens at an elevation of ca. 457 m (1,500 ft), is dominated by a canopy of scrub oak and pitch pine, *Pinus rigida* Mill., and an understory of trailing arbutus, *Epigaea repens* L., wintergreen, *Gaultheria procumbens* L., sheep laurel, *Kalmia angustifolia* L., blueberries, *Vaccinium angustifolium* Ait. and *V. vacillans* Torr. (Ericaceae); red chokeberry, *Aronia arbutifolia* (L.) L. (Rosaceae); sweetfern, *Comptonia peregrina* (L.) J. M. Coult. (Myricaceae); and fly-poison, *Amianthium muscaetoxicum* (Walt.) Gray (Liliaceae).

In 1985 samples were taken from 23 April through 15 August by tapping branches of scrub oak over a shallow insect net and collecting the first 10 individuals en-

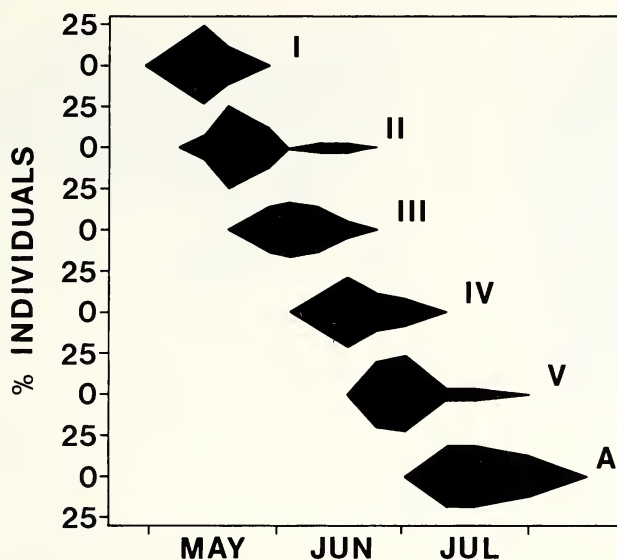


Fig. 1. Seasonal occurrence of *T. elliptica*. Number of individuals of each stage is expressed as percentage of total observations of that stage (I–V = nymphal instars, A = adults).

countered. Collections were made weekly except for a 10-day interval in early July and a 2-week interval in early August. Additional field observations and collections were made at the study site during June–August 1984 and April–September 1986 and in an extensive scrub oak barrens near Long Pond (Monroe Co.), Pennsylvania, in August 1986.

*Descriptions of adults and immatures.* We attempted to borrow the type specimen of *T. elliptica* that Doering (1938) stated was “according to Melichar in the Museum in Budapest.” In his monograph of the Issidae, Melichar (1906) did not state that the specimen to which Doering referred was indeed at that museum; we assume that Germar’s type has been lost. We were able to borrow a specimen from the Hungarian Natural History Museum in Budapest that corresponded with other specimens collected throughout the eastern United States but not with Doering’s description and illustration based on material from Texas.

Descriptions of nymphs are based on the following field-collected specimens: PENNSYLVANIA: Schuylkill Co., I81 N, 4.5 mi S Frackville (1985 specimens; 1984 specimens = 4.8 mi S), A. G. Wheeler, Jr., Collector, taken on *Quercus ilicifolia* (I–V = nymphal instars, ♂ and ♀ = adults), 21 June 1984 (2-II, 11-III, 3-IV), 27 June (1-II, 6-III, 9-IV, 2-V), 4 July (2-III, 11-IV, 4-V), 12 July (6-V), 14 July (4-III), 19 July (1♂, 1♀), 8 May 1985 (5-I), 14 May (8-I, 3-II), 20 May (4-I, 10-II), 30 May (5-II, 6-III), 4 June (7-III), 11 June (1-II, 6-III, 4-IV), 18 June (1-II, 2-III, 8-IV), 25 June (4-IV, 6-V), 2 July (3-IV, 7-V), 12 July (1-V), 19 July (1-V, 1♂, 1♀), 1 Aug (1♂, 1♀).

Adults were pinned and nymphs preserved in 70% ethyl alcohol. Measurements are given in mm as mean  $\pm$  SD. Length was measured from apex of vertex to apex of wings for adults or apex of abdomen for nymphs, thoracic length along the midline

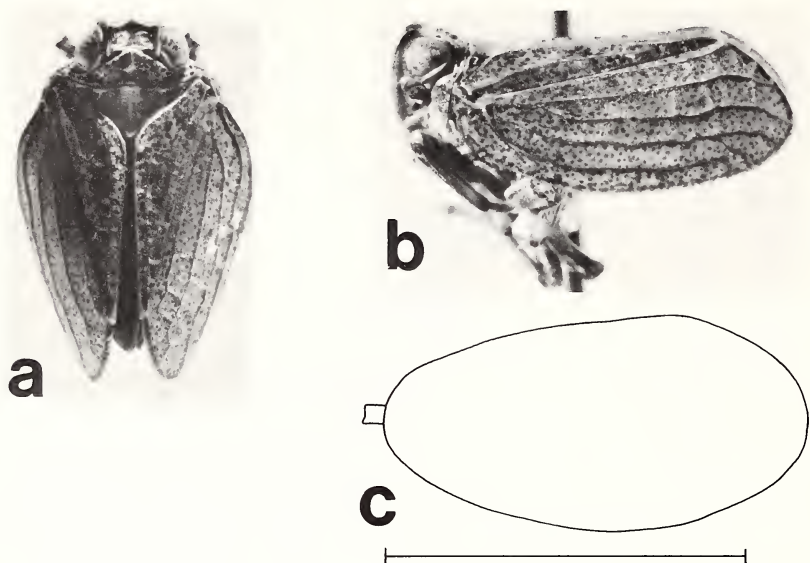


Fig. 2. *T. elliptica*. a. Adult, dorsal view. b. Adult, lateral view. c. Egg, bar = 1 mm.

from the anterior margin of the pronotum to the posterior margin of the metanotum, and width across the widest part of the body. Eggs were obtained by removing them from a dried, pinned female. Eggs were restored by immersion in 10% lactic acid at 80°C for 30 min, fixation in 37% formaldehyde solution for 24 hr, then transference to 70% isopropyl alcohol.

#### RESULTS AND DISCUSSION

##### *Thionia elliptica* (Germar)

*Field study.* *T. elliptica* is univoltine (Fig. 1) and, based on attempts to collect this issid on white oak, *Q. alba* L., and other trees and shrubs, is apparently limited in its host preference to *Q. ilicifolia* at the study site. However, adult specimens from Missouri, well outside the range of scrub oak, *Q. ilicifolia*, were found on blackjack oak, *Q. marilandica* Muenchh.

In 1985 nymphs were first observed on 8 May when host foliage was beginning to expand. Adults appeared in the sample of 12 July and were collected until 31 July but probably were present until early August; they were absent on 15 August when the next sample was taken (Fig. 1). Seasonal history was similar in 1986. A first-instar nymph was collected on 14 May; adults appeared by 1 July and were present until late August.

This issid probably overwinters in the egg stage, as do acanaloniids and flatids with similar life cycles (Wilson and McPherson, 1981a, b); this contention is supported by the occurrence of a gravid female collected on 19 July 1985 and by the absence of adults in the spring (Fig. 1). Females likely insert eggs in woody tissue as they have teeth on valvulae 2 (Fig. 3e), and the eggs have a sculptured chorion; both

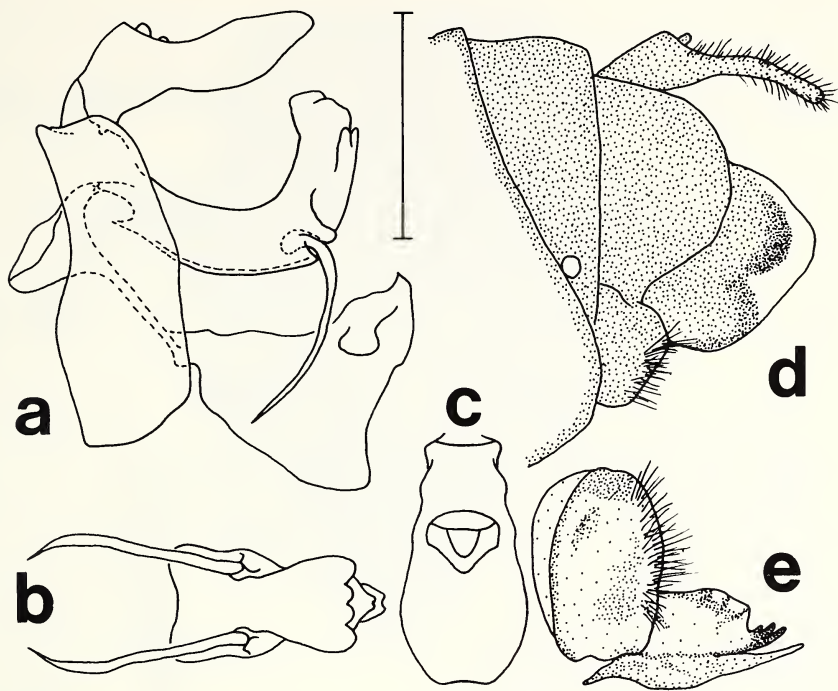


Fig. 3. *T. elliptica* genitalia. a. Male, lateral view of complete genitalia. b. Male, ventral view of aedeagus. c. Male, dorsal view of anal tube. d. Female, lateral view of complete genitalia. e. Female, lateral view of valvula 2. Bars = 1 mm.

features are present in acanaloniids and flatids that oviposit in woody tissues (Wilson and McPherson, 1981a, b).

Nymphs and adults of *T. elliptica* were observed on branches of scrub oak, which appear to be the principal feeding sites on their hosts. This planthopper was consistently beaten from larger branches rather than from the foliage or small branches. A larva of the epipyropid moth *Fulgoraecia exigua* (Edwards) (= *Epipyrops barbariana* Dyar) was observed on the abdomen of a nymph. Wilson and McPherson (1979) listed the known planthopper hosts of this parasitic moth.

*Descriptions of adults and immatures.* ADULTS (Figs. 2a, b, 3, 7). Length—male  $6.2 \pm 0.22$ ; female  $7.2 \pm 0.15$ ;  $N = 10$  for each. Specimens differ from *T. elliptica* as described and illustrated by Doering (1938) in having a wider range of color variation from yellowish and tan to almost black ground color with small dark brown to black spots, smaller size, and different male genitalia.

Male genitalia (Fig. 3a–c). Pygofer, in lateral view, higher than wide. Anal flap, in dorsal view, longer than wide, with a broad, weak apical notch, segment 11 visible near middle as a short ring bearing a stout anal style. Styles (harpagones of Doering (1938)), in lateral view, subtriangular, widest in posterior  $\frac{1}{3}$ , with lobelike flap extending laterally near dorsoposterior corner. Aedeagus subcylindrical, bearing a scler-



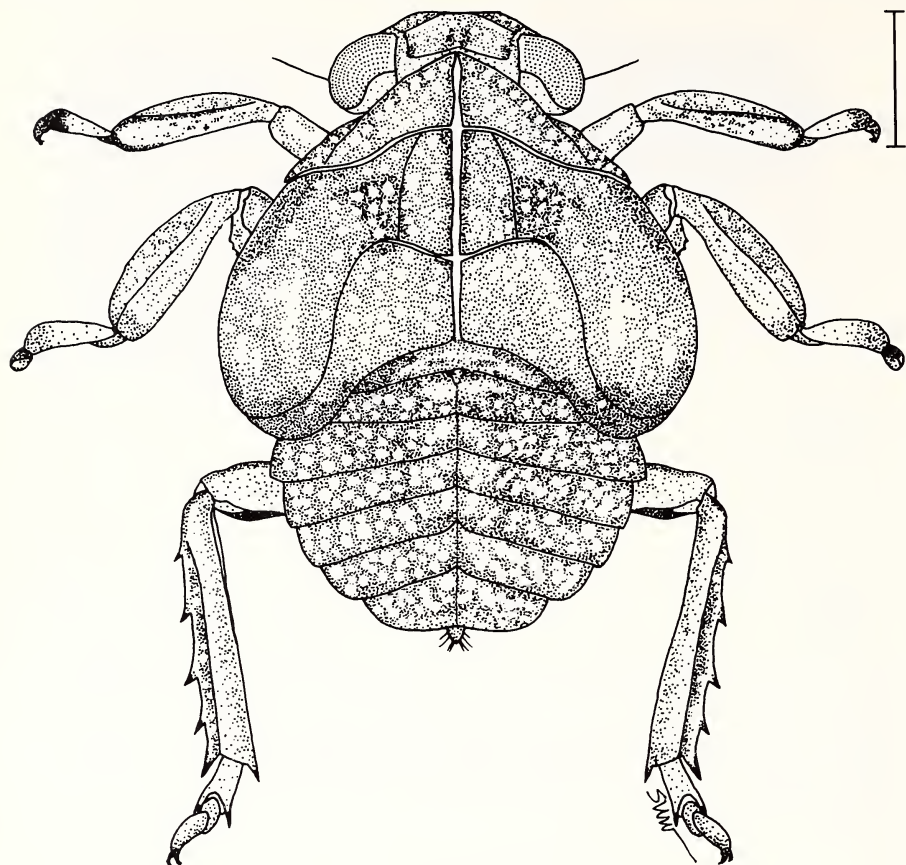


Fig. 4. *T. elliptica* fifth instar. Bar = 1 mm.

otized theca which is difficult to distinguish; in lateral view, theca fully surrounding aedeagus in basal  $\frac{1}{2}$ , then dividing into dorsal and ventral flaps, dorsal flap extending to apex of aedeagus, with prominent posteroventrally directed lobe posterior to aedeagal process, ventral flap extending nearly to apex of aedeagus, in ventral view, ventral flap with 4 lobes at apex; aedeagus, in lateral view, with an elongate, moveable, curved spinelike process on each side, processes originating in posterior  $\frac{1}{2}$  from between thecal flaps and extending posteroventrally; aedeagus, in ventral view, extending beyond theca, apex bilobed.

Female genitalia (Fig. 3d, e). Anal flap spatulate, longer than wide, apical notch weak. Valvulae 1 forming short, covering flaps, subquadrate, heavily sclerotized basal  $\frac{3}{4}$  weakly to strongly lobate. Valvulae 2 almost hidden by valvulae 1, apices visible in ventral view, with 3 black apical teeth and slender process originating on ventromedial aspect and extending caudad. Valvulae 3 completely hidden by surrounding valvulae 1 and 2, slender, spinelike, lacking teeth.

*Specimens examined.* ARKANSAS: Polk, 21 August 1928 (1♂), J. Beamer; Washington Co., 18 September 1939 (1♂, 1♀) (housed in the Snow Museum, University

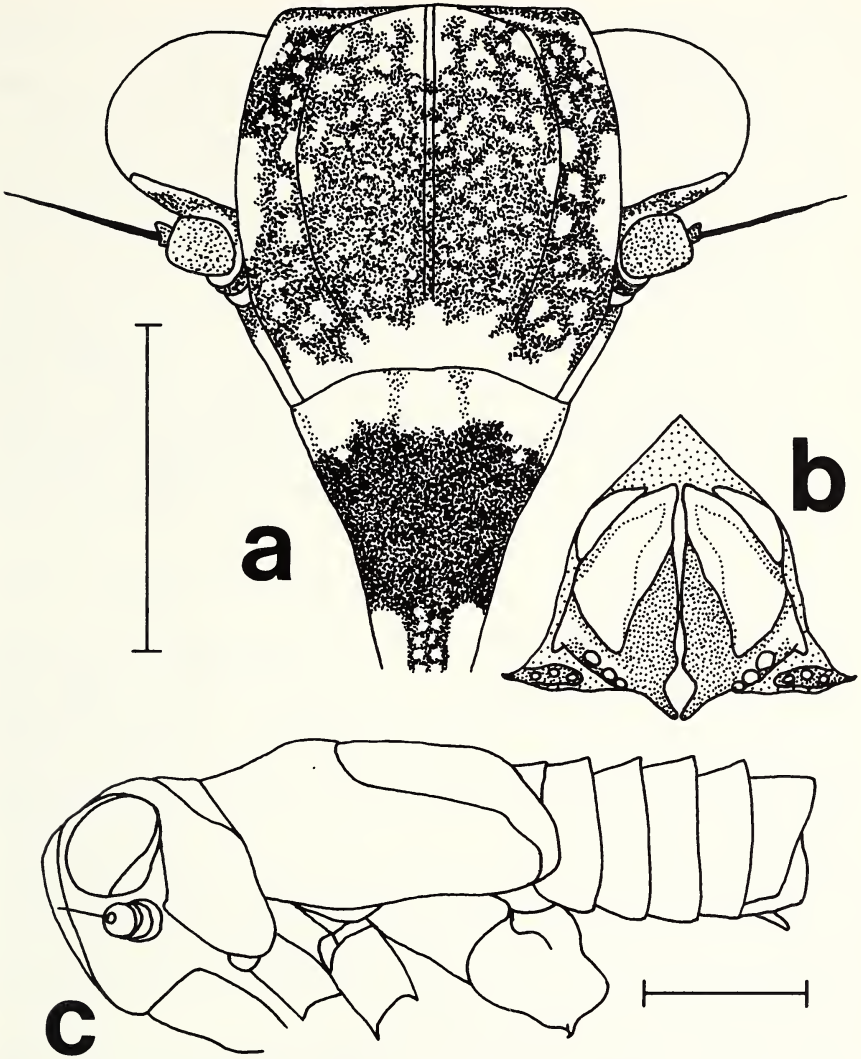


Fig. 5. *T. elliptica* fifth instar. a. Frontal view of head. b. Caudal view of abdomen. c. Lateral view. Bars = 1 mm.

of Kansas, Lawrence); KENTUCKY: Louisville (1♀, with labels “*elliptica* det. Melichar” and “*Thionia elliptica* Germ” (in Horvath’s handwriting according to T. Vasarhelyi) (housed in the Hungarian Natural History Museum, Budapest); MISSOURI: Barry Co., 6 August 1949 (1♂), C. Wingo; Boone Co., Ashland Wildlife Area, 3 September 1969, Malaise Hatch 623 (1♀); Columbia, 2 September 1979, E. G. Riley (1♀); Pennicles, 15 mi N Columbia, 1 July 1957, coll. F. W. Wood (1♀); Carter Co., Sky Line Drive nr. Van Buren, 22 July 1978, E. G. Riley (2♂); Crawford Co., 21 July 1972, T. R. Yonke (1♂), 28 June 1974, D. Kopp (1♀), 12 mi E Steelville, 20

August 1980, Coll. E. G. Riley (1♂); Dent Co., 26 July 1973, (1♂); 19 September 1972, 29 July 1973 (1♀), window fl. trap (2♂, 1♀); 12 September 1972 (1♂), 26 July 1973 (1♂), 10 mi E Salem, 2 July (1♂), 19 July (1♀), 26 July 1972 (1♂), 16 August (1♀), 23 August 1972 (1♀), M. P. Roling; Douglas Co., 14 September 1979, R. A. McKinney (1♀); Jefferson Co., Mastodon State Park, 3 August 1982, coll. T. C. MacRae, on *Quercus marilandica* (1♂); Maries Co., 6 mi N Vichy, 10 July 1974, S. E. Thewke (1♂); Phelps Co., Vichy Fire Tower, 2 August 1972, M. Roling (1♂); Reynolds Co., 20 July 1972, M. Roling (1♂); Shannon Co., Loggers Lake RS, 16 July 1983, T. C. MacRae (1♂); Owls Bend, 11 September 1969, L. R. Hanning, on oak leaf (1♀); Stoddard Co., 2 mi SW Bellcity, Ardeola Hill, Crowley's Ridge, 7 July 1979, E. G. Riley (1♀); Texas Co., G. O. White St. Nursery, 3 September 1977, coll. E. G. Riley (1♂); Wayne Co., Williamsville, 7 September 1956, M. Ferril (1♀) (housed in the collection at the University of Missouri, Columbia); NORTH CAROLINA: Black Mts., 15–20 June 1912 (1♂, 1♀), 21–30 June (2♂), Beutenmuller (housed in the collection at Cornell University, Ithaca, New York); PENNSYLVANIA: Monroe Co., Long Pond, A. G. Wheeler, Jr., Collector, taken on *Quercus ilicifolia*, 1 August 1986 (7♂, 2♀); Schuylkill Co., 181 N, 4.8 mi S Frackville, A. G. Wheeler, Jr., Collector, taken on *Quercus ilicifolia*, 19 July 1984 (2♂), 19 July 1985 (1♂, 1♀), 1 August 1985 (1♂).

FIFTH INSTAR (Figs. 4, 5, 7). Length  $5.3 \pm 1.03$ ; thoracic length  $2.0 \pm 0.11$ ; width  $3.5 \pm 0.29$ .  $N = 10$ .

Form subcylindrical, convex dorsally, slightly flattened dorsoventrally, widest across mesothoracic wingpads; medium brown to black, heavily marked with cream spots.

Vertex ca.  $3 \times$  broader than long, anterior margin carinate, subacute, meeting inner carinae of frons medially, lateral and posterior margins weakly carinate. Frons slightly wider than long, dorsal margin nearly straight, lateral margins strongly convex and carinate (outer carinae) paralleled by inner carina on each side, with median longitudinal carina; juncture with clypeus acutely concave; ca. 30 pits, most corresponding with pale spots, between each inner and outer carina. Clypeus consisting of a subconical basal anteclypeus and a subconical distal postclypeus, anteclypeus black with pale at juncture with frons, postclypeus pale with black markings. Beak 3-segmented, extending to metacoxae; segment 1 obscured by postclypeus, segments 2 and 3 subequal. Eyes reddish with pale stripes. Antennae 3-segmented; scape short and ringlike; pedicel ca.  $2 \times$  length of pedicel; scape with more than 15 pits; flagellum whiplike distally, bulbous base ca.  $\frac{1}{4} \times$  that of pedicel.

Thoracic nota divided by longitudinal mid-dorsal line into 3 pairs of plates. Pronotal anterior margin broadly rounded and carinate, posterior margin sinuate; each plate with 4 irregular rows of pits, totalling ca. 30 pits (lateralmost pits not visible in dorsal view). Mesonotal median length  $1.5 \times$  that of pronotum; each plate with carina originating on anterior margin in median  $\frac{1}{4}$  and extending posterolaterally to posterior margin; cluster of 9–11 pits just lateral to carina and 6–8 pits on wingpad; wingpad lobate, extending nearly to apex of metanotal wingpad. Metanotal median length ca.  $0.7 \times$  that of mesonotum; each plate with weak longitudinal carina originating on anterior margin in median  $\frac{1}{3}$  and extending to posterior margin; wingpad broadly lobate, extending laterally to tergite 3. Pro- and mesocoxae elongate, subcylindrical, posteromedially directed; metacoxae fused to sternum. Metatrochanters each with a row of 11 interlocking, flattened teeth on median aspect. Femora slightly



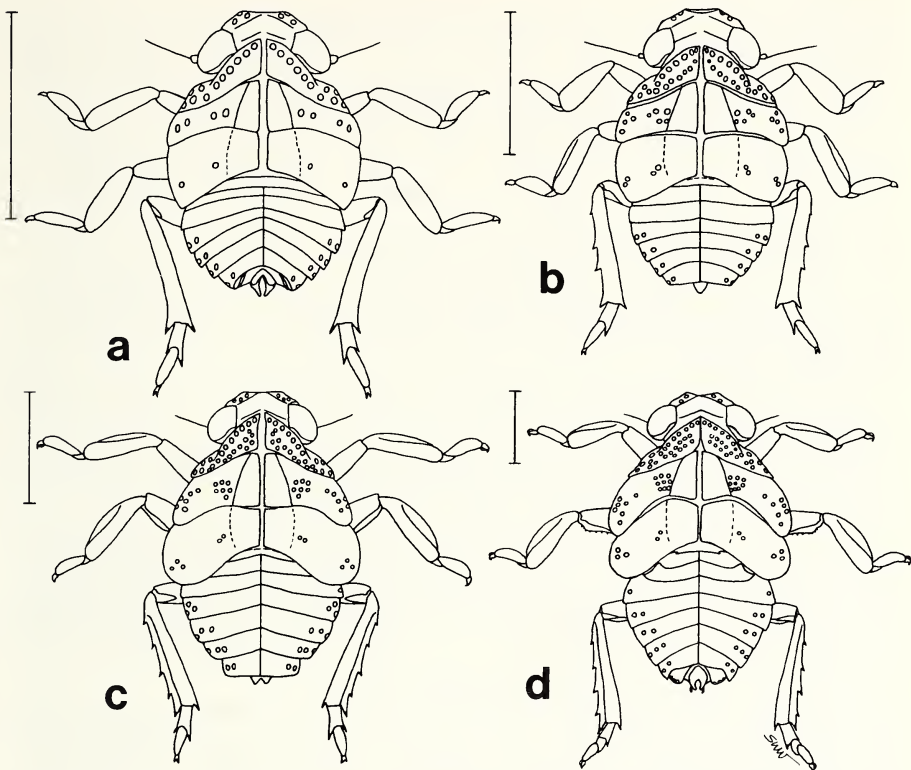


Fig. 6. *T. elliptica* first through fourth instars, a. First instar. b. Second instar. c. Third instar. d. Fourth instar. Bars = 1 mm.

flattened, subtriangular in cross section; pro- and mesofemora shorter and broader than metafemora. Pro- and mesotibiae slightly flattened and subtriangular in cross section, outer aspect strongly concave; metatibiae laterally flattened, longitudinal row of 4–5 lateral spines on shaft and transverse apical row of 7–9 spines (generally 8) on plantar surface. Pro- and mesotarsi each with 2 tarsomeres; tarsomere 1 wedge-shaped, tarsomere 2 subcylindrical and curved. Metatarsi each with 3 tarsomeres; tarsomeres 1–3 subcylindrical; tarsomere 1 with transverse apical row of 8–10 spines (generally 9) apically on plantar surface; tarsomere 2 with 2 spines, 1 on each side, and a large median lobe on plantar surface; tarsomere 3 similar to terminal tarsomere of other legs. All legs with terminal pair of black curved claws and a clear, membranous, lobate, median pulvillus.

Abdomen 9 segmented, subtriangular in cross section, widest across segment 3; segments 8–9 telescoped anteriorly; 7–8 with a pair of elongate, oval, white caudal waxpads. Segment 9 elongate vertically, surrounding anus, with 2 pits and a small fingerlike process on each side; tergites 2–7 with a weak median longitudinal carina. Each tergite with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view due to curving of tergites onto ventral aspect): tergite 3 with 4–5 pits, 4 with 5–6, 5 with 6–7, 6 with 7, 7 with 7–8, and 8 with 5–6.



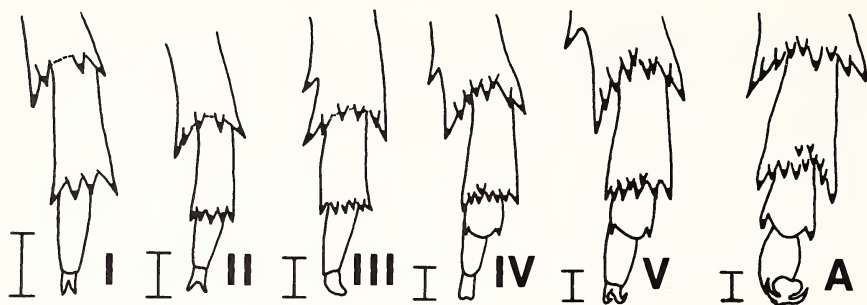


Fig. 7. *T. elliptica* apices of metathoracic legs, plantar surface. I-V = nymphal instars, A = adult. Bars = 0.1 mm.

FOURTH INSTAR (Figs. 6d, 7). Length  $5.0 \pm 0.53$ ; thoracic length  $1.6 \pm 0.07$ ; width  $2.3 \pm 0.14$ . N = 10.

Vertex ca.  $3.5 \times$  broader than long. Frons with juncture with clypeus concave and broadly rounded. Antennal pedicel with ca. 12-14 pits.

Pronotal plates each with ca. 27-28 pits in 3 irregular rows. Mesonotal plates each with 6-9 pits just lateral to carina; wingpad broadly lobate and covering ca.  $\frac{1}{2}$  metanotal wingpad laterally. Metanotal wingpad with 3 pits in lateral  $\frac{1}{3}$ . Metatrochanter with a row of 9 flattened teeth on median aspect. Metatibiae with apical transverse row of 7-8 spines (generally 7) on plantar surface. Metatarsomere 1 with apical transverse row of 6-8 spines on plantar surface.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 3 with 3-5 pits, 4 with 7, 5 with 5-7, 6 with 5-6, 7 with 6-7, 8 with 3-5; segment 9 with 2-3 pits.

THIRD INSTAR (Figs. 6c, 7). Length  $3.6 \pm 0.46$ ; thoracic length  $1.3 \pm 0.05$ ; width  $1.8 \pm 0.07$ . N = 10.

Frons with ca. 23 pits between each inner and outer carina. Antennal pedicel ca.  $3 \times$  length of scape and with ca. 8 pits; bulbous portion of flagellum slightly less than  $\frac{1}{2} \times$  length of pedicel.

Pronotal plates each with 21-28 pits in 3 irregular rows. Mesonotal plates each with 6-7 pits just lateral to carina and 5-6 pits in lateral  $\frac{1}{3}$ . Metanotal plates each with 2-4 very obscure pits just lateral to carina and 3-4 pits in lateral  $\frac{1}{3}$ . Metatibiae with an apical transverse row of 6-7 (generally 6) spines on plantar surface. Metatarsi with 2 tarsomeres; tarsomere 1 cylindrical, with an apical transverse row of 6 spines on plantar surface; tarsomere 2 similar to terminal tarsomeres of other legs.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 3 with 3-4 pits, 4 with 4-5, 5 with 5, 6 with 4-5, 7 with 5, 8 with 3-4; segment 9 with 2 pits.

SECOND INSTAR (Figs. 6b, 7). Length  $2.6 \pm 0.37$ ; thoracic length  $0.9 \pm 0.04$ ; width  $1.3 \pm 0.07$ . N = 10.

Vertex ca.  $4 \times$  wider than long. Frons with ca. 18-20 pits between each outer and inner carina. Antennal pedicel appearing to have 4-5 very obscure pits.

Pronotal plates each with 20-21 pits in 2 distinct transverse rows. Mesonotal plates each with group of 5 pits just lateral to carina and 4 pits near lateral border. Metanotal plates each with 2 pits just lateral to very weak carina and 1-2 pits near lateral margin.

Metatibia with 3 lateral spines on shaft and an apical transverse row of 5 spines on plantar surface. Metatarsomere 1 with an apical transverse row of 5 spines on plantar surface.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 3 with 1 pit, 4–7 each with 3 pits, 8 with 2 pits; segment 9 with 2 pits.

FIRST INSTAR (Figs. 6a, 7). Length  $1.9 \pm 0.29$ ; thoracic length  $0.7 \pm 0.02$ ; width  $0.9 \pm 0.04$ ,  $N = 10$ .

Vertex ca.  $3 \times$  wider than long. Frons with 12 pits between each inner and outer carina. Antennal pedicel ca.  $2 \times$  length of scape; pedicel lacking pits.

Pronotal plates each with 11 pits in 1 transverse row (along carina). Mesonotal plates each with 2 pits just lateral to carina and 2 pits near lateral margin. Metanotal plates each with 1 pit just lateral to carina and 1 pit near lateral margin. Metatibiae lacking spines on shaft; with an apical transverse row of 4 spines on plantar surface. Metatarsomere 1 with an apical transverse row of 4 spines on plantar surface.

Abdominal tergites each with the following number of pits on either side (lateralmost pits not visible in dorsal view): tergite 3 with 0 pits, tergites 4–7 each with 2 pits, tergite 8 with 1 pit; segment 9 with 2 pits.

EGG (Fig. 2c). Length  $1.5 \pm 0.03$ ; width  $0.8 \pm 0.01$ .  $N = 3$ .

Eggs elongate, oval; white (when restored as described in Materials and Methods); chorion translucent, with polygonal sculptured pattern (not illustrated), cephalic end with short cylindrical process.

### *Thionia obrienae* Wilson, new species

*Adults.* Length—male 6.6 (length from vertex to apex of hindwing; specimen with forewings destroyed; comparable measurement of male *T. elliptica* = 5.6); female 10.0;  $N = 1$  of each). This species differs from *T. elliptica* in its larger size; the male may be separated from *T. elliptica* males by its slightly stouter anal flap, presence of an elongate spine on each aedeagal process, smaller lobe just posterior to origin of aedeagal process, and bilobate rather than quadrilobate apex of theca in ventral view. The female has distinctly larger genitalia, valvulae 1 with heavily sclerotized basal  $\frac{3}{4}$  not lobate, and apices of valvulae 2 longer and more strongly curved. *T. obrienae* was described and illustrated, as *T. elliptica*, by Doering (1938:459–460, 542–547, 550–553).

*Specimens examined.* HOLOTYPE: TEXAS: Concan, 4 June 1933, P. W. Oman, with labels “*Thionia elliptica* (Germ) Det. Doering”, “♂,” “See slide no 69 (F) K. Doering,” “Holotype, *Thionia obrienae* Wilson”; ALLOTYPE: TEXAS: Boerne, 2 July 1936, R. H. Beamer, with labels “*Thionia elliptica* (Germ) Det. Doering,” “♀,” “Allotype, *Thionia obrienae* Wilson.” Types in the Snow Museum, University of Kansas, Lawrence. The species is named in honor of Dr. Lois B. O'Brien, who first suggested that it may be undescribed and who has contributed immeasurably to our knowledge of New World Fulgoroidea.

### COMMENTS ON THE HIGHER CLASSIFICATION OF THE ISSIDAE AND ACANALONIIDAE

The higher classification of the Issidae was last reviewed by Fennah (1954) who listed five subfamilies. One of these was the subfamily Acanaloniinae which, both

previous and subsequent to his work, has been recognized as a family, especially by many North American workers (e.g., Muir, 1930; Metcalf, 1958; O'Brien and Wilson, 1985). The family status is based solely on the absence of lateral spines on the metatibiae of adults; all other features given by Metcalf (1954) vary within the family or are also shared with some issids. Certain features of the nymphal morphology do not support the separation of these planthoppers from the issids. Nymphs of *Acanalonia bivittata* (Say), *A. conica* (Say) and *A. latifrons* (Walker) have lateral metatibial spines in the second through fifth instars and have waxpads on the membranous regions of tergites 6–8 (Wilson and McPherson, 1981a; Wilson, personal observation). They are, in fact, quite similar to nymphs of *T. elliptica*, which also have metatibial lateral spines and waxpads associated with tergites 8–9.

In contrast, nymphs of *Acanalonia* and *Thionia* differ greatly from those of the calisceline *Bruchomorpha oculata* Newman (Wilson and McPherson, 1981c), which lacks waxpads. Nymphs of *Acanalonia*, *Thionia* and the flatids *Anormenis*, *Metcalfa*, *Ormenaria*, *Ormenoides*, and *Cyarda* are more similar to each other morphologically than any are to *Bruchomorpha* (Wheeler and Hoebeke, 1982; Wilson and McPherson, 1981a, b, c; Wilson and Tsai, 1984). Scudder's (1979) "Caliscelidae" may indeed have some validity.

Based on nymphal and adult morphology, we feel that Acanaloniidae should be lowered to subfamily rank within Issidae as suggested by Fennah (1954). Phylogenetic analyses of the subfamilies and tribes will be necessary to clarify the relationships and validity of issid higher taxa.

#### ACKNOWLEDGMENTS

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## ANTENNAL SENSILLA AND SETAL PATTERNS OF THE GOLDENROD GALL FLY, *EUROSTA SOLIDAGINIS* (FITCH) (DIPTERA: TEPHRITIDAE)

CAREY E. VASEY AND EDWARD RITTER

Biology Department, SUNY at Geneseo, Geneseo, New York 14454

**Abstract.**—The sensilla and setal patterns of the antennae of the goldenrod gall fly were investigated by scanning electron microscopy. Sexual dimorphism is clearly evident on the first flagellomere and arista of the flies. On the flagellar surface, the female exhibits only one type of trichoid sensillum while the male exhibits three types; a trichoid type like that of the female and two sizes of basiconic sensilla. The point of attachment of the arista of the female bears an additional cup-like articulation that is not present in the male and the female also has an obvious button-like protuberance on the lateral border of each arista near the distal end, which is absent in males.

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*Eurosta solidaginis* (Fitch) is responsible for the formation of round galls commonly observed on the stems of various species of the goldenrod *Solidago*. Uhler (1951) has furnished the most complete work to date on the biology and ecology of this fly and indicated that the species is widely distributed throughout the United States and Canada. Other studies by Milne (1940) and Miller (1959) have also contributed information regarding the natural history of this insect.

The method by which *E. solidaginis* selects the appropriate species of *Solidago* for oviposition is unknown. It is conceivable that the attraction may be chemosensory and that the antennal sensilla could play an important role in host selection. Several recent studies on the antennae of Diptera have demonstrated the presence of such chemosensory sensilla (Bay and Pitts, 1976; White and Bay, 1980; Honda, Ishikawa and Matsumoto, 1983; Vasey and Ritter, 1983; and Venkatesh and Singh, 1984). Up to now, no such inquiry has been undertaken on the goldenrod gall fly.

The purpose of this investigation was to examine the sensilla and setal patterns of the antennae of *E. solidaginis* and to provide the basis for additional demonstrations of the importance of antennal sensilla in mating and host selection.

### MATERIALS AND METHODS

Specimens of *Eurosta solidaginis* initially used in this work were obtained from the insect collections of the State University of New York College of Arts and Sciences at Geneseo. All of these had been reared from galls collected on *Solidago canadensis* L. Additional specimens were reared from galls supplied by Dr. Warren G. Abrahamson of Bucknell University. These had been collected from *Solidago altissima* L. in February 1985 near Lewisburg, Pennsylvania, and had been held at  $-23^{\circ}\text{C}$  until the time they were shipped. When received, the galls were placed in rearing cages for 10–14 days at which time flies emerged. Specimens were killed with ethyl acetate and then decapitated. Heads of 10 males and 10 females were examined. Five of each sex were mounted laterally and the remaining five were mounted full face on aluminum stubs with silver paint. The specimens were then gold coated in

a Polaron diode sputterer and examined on an ISI Alpha-9 Scanning Electron Microscope.

#### OBSERVATIONS AND DISCUSSION

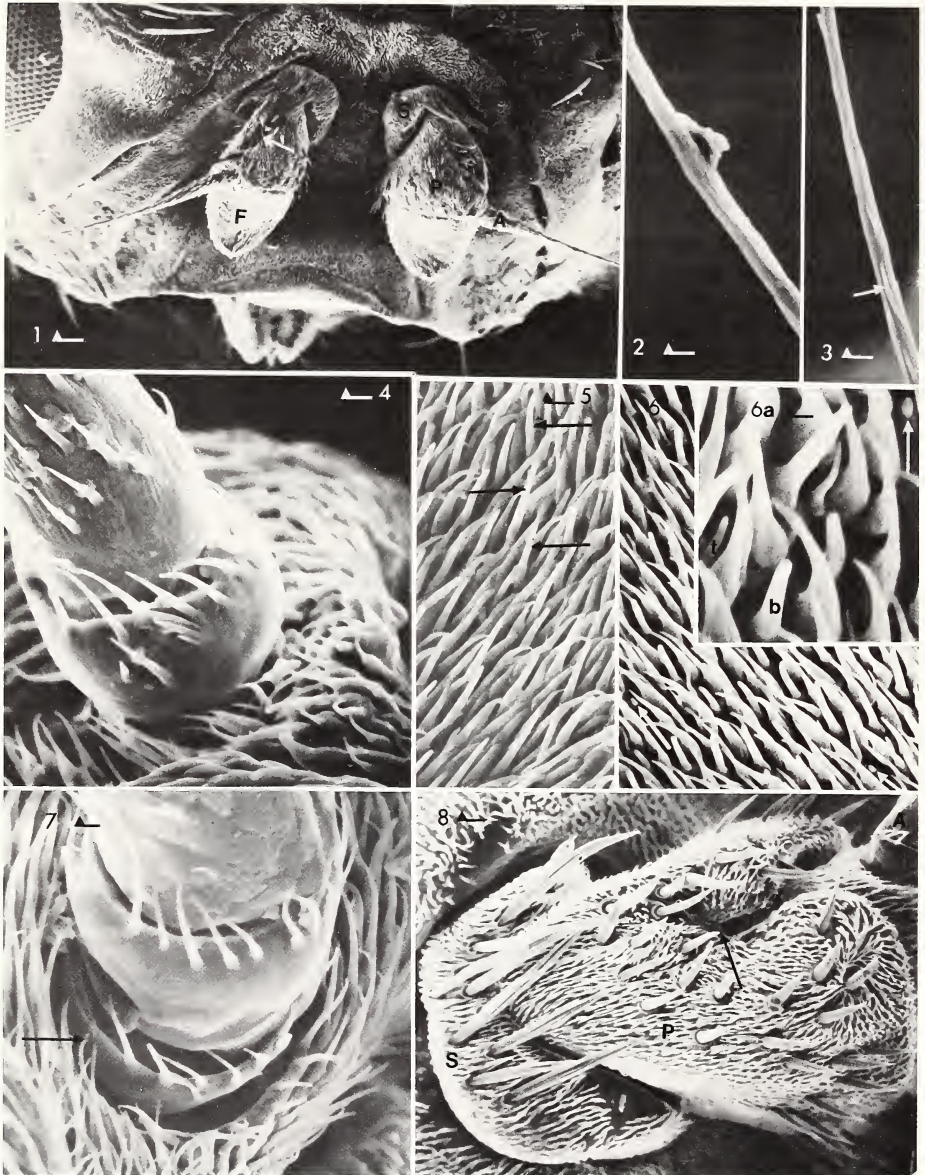
The antenna of the goldenrod gall fly was superficially described by Uhler (1951). It consists of a scape, pedicel and flagellum, the basal subsegment or flagellomere of which is greatly enlarged and bears a non-plumose arista arising dorsolaterally from its base (Fig. 1).

Although the first flagellomere is similar in size and shape in both sexes, there is a marked sexual dimorphism evident as to type and arrangement of the sensilla. In the female (Fig. 5) each flagellum is densely covered on all sides by microtrichia. Interspersed with these microtrichia are a large number of linearly placed, elongate, trichoid sensilla that are similar to the A-type of Dethier (1976). These are readily identified from the microtrichia by their gently rounded distal ends and lighter color. These sensilla also resemble the thin walled chemoreceptors described by Slifer (1970). Such sensilla have been described on the antennae of other Diptera, for example, that of the face fly by Bay and Pitts (1976) and the horn fly by White and Bay (1980).

The flagellar segment of the male, like that of the female, is densely covered with microtrichia. Interspersed with these are three different types of sensilla (Fig. 6, 6a). The elongate trichoid sensilla (t) described for the female are present, but are not as numerous and are not as regularly arranged. There are in addition two sizes of basiconic sensilla. The shorter ones (Fig. 6a, arrow) may occur singly or occasionally in pairs while the longer (b) of these are more numerous and always arise singly. In each case they ascend from well marked areas that are surrounded by microtrichia. These basiconic sensilla appear to be similar to the thick walled chemoreceptors described by Slifer (1970).

The point of attachment of the arista to the flagellum is different in each sex. In the female there is an additional cup-like basal articulation (Fig. 7) which is not present in the male (Fig. 4). In both sexes, the edges of the articulation points are encircled by a single row of unbranched microtrichia. The aristae of both sexes are non-plumose; they are, however, sparsely covered with small branched microtrichia that decrease in number and frequency distally. As one moves closer to the terminus, the arisal microtrichia become flattened and scale-like in appearance (Fig. 3). The male arista bears no other structure. The female, on the other hand, has an obvious button-like protuberance which is found on the inner, lateral border of each arista, approximately  $\frac{1}{3}$  distant from the tip, near the point where the arista begins to narrow sharply (Fig. 2). These are obviously sensilla and, by their appearance, suggest a chemosensory function. We cannot find reference to any such structure previously reported in the literature.

SEM investigation of the scape and pedicel shows setal patterns but reveals nothing in the way of sensilla. The pedicel is marked by a conspicuous dorsal cleft (Figs. 1, 8) found in other Tephritidae (McAlpine, 1981). The surfaces of both subsegments are covered with the same type of microtrichia as described above for the first flagellomere. However, interspaced with these (Fig. 8) are two sizes of fluted setae which arise from sockets. The dorsal leading edge of the scape bears two alternating rows of anteriorly directed long setae (Fig. 8). Those of the pedicel are shorter. A staggered row of these setae line the innermost margin of each cleft while the re-



Figs. 1–8. Front view of *Eurosta solidaginis* showing paired antennae: arrow indicates dorsal, longitudinal cleft, first flagellomere (F), arista (A), pedicel (P), and scape (S). 50 $\times$ , Bar = 56.5  $\mu$ m. 2. Arista of female showing inner, lateral, button-like protuberance. 1,000 $\times$ , Bar = 2.6  $\mu$ m. 3. Arista of male. Arrow indicates flat, scale-like microtrichia. 400 $\times$ , Bar = 10  $\mu$ m. 4. Junction of the arista to the first flagellomere of the male. 700 $\times$ , Bar = 3.7  $\mu$ m. 5. Dorsal surface of first flagellomere of female. Arrows indicate linear arrangement of trichoid sensilla. 700 $\times$ , Bar = 3.7  $\mu$ m. 6. Dorsal surface of first flagellomere of male. Long basiconic sensillum (b), short basiconic sensilla (arrow), trichoid sensillum (t). 700 $\times$ , Bar = 3.7  $\mu$ m. 6a. 2,000 $\times$ , Bar =



maining setae are irregularly arranged on the dorsal surface and continue ventrally. The setae of the ventral aspect are longer than those found dorsally.

According to Uhler (1951), the male emerges from the gall one to two days before the female and orients himself on the terminal bud of the host goldenrod plant and awaits the female. It is conceivable that the flagellar sensilla of the male plays a role in locating the suitable portion of the host plant using chemosensory cues.

One of the major differences between the sexes, however, is the button-like protuberance present only on the arista of the female. Structurally it resembles a sensory sensillum which would be capable of detecting stimuli emanating from the male. Such antennal sensilla would explain attraction to a suitable host plant which then could result in mating and subsequent oviposition.

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1.3  $\mu\text{m}$ . 7. Junction of the arista to the first flagellomere in the female showing additional cup-like articulation. 700 $\times$ , Bar = 4.2  $\mu\text{m}$ . 8. Side view of scape (s) and pedicel (p); arrow indicates dorsal longitudinal cleft. 200 $\times$ , Bar = 12.8  $\mu\text{m}$ .



## BOOK REVIEW

**Spinnenfauna Gestern und Heute: Fossile Spinnen in Bernstein und ihre Heute Lebenden Verwandten.**—Jörg Wunderlich. 1986. Erich Bauer Verlag of Quelle & Meyer, Wiesbaden, West Germany. 283 pp. No price supplied.

This is the first in a projected series of three volumes devoted to amber spider fossils and their relationships. The second and third volumes will provide detailed studies of fossils in Dominican and Baltic amber, respectively. This first volume is of special interest to neontologists, for it includes explications of Wunderlich's views on the placement of both fossil and extant taxa, particularly those belonging to the superfamily Araneoidea (orb-weavers and their close relatives), as well as an overview of the amber fauna. Many illustrations (even color photographs), and some descriptions, of Recent taxa are included. Although written in German, Wunderlich provides an English abstract for each chapter and helpful lists of nomenclatorial changes. Those lists have some unfortunate omissions, however. For example, Wunderlich places the now widely recognized families Anapidae, Symphytognathidae, and Mysmenidae in a single family (Anapidae); although the sinking of Symphytognathidae is noted in his lists, the demotion of Mysmenidae is not. Similarly, Wunderlich evidently considers at least part of the Amaurobiidae (the subfamily Amaurobiinae) to belong to the Agelenidae, but only his synonymy of the agelenid subfamily Coelotinae with the Amaurobiinae is included in the lists, and no justification of the concomitant sinking of Amaurobiidae, or commentary on the placement of the other amaurobiid subfamilies, is provided.

The first chapter includes a summary table of Recent families and subfamilies represented in Baltic or Dominican amber (or both); by Wunderlich's reckoning, 33 out of 46 families currently found in Europe are represented by Baltic fossils (plus four others not found in Europe today, including the Archaeidae, first described from Baltic amber but subsequently found alive in Madagascar, South Africa, and eastern Australia). The same number of Recent families (37) is reported from Dominican amber. Additional families, however, contain only amber specimens; some of these taxa (established mostly by Petrunkevitch) are of dubious validity, and reinterpretations and new synonymies are provided for several of them. Wunderlich's earlier argument for placing the Baltic Spatiatoridae in the Palpimanoidea is amplified with a useful data matrix; of special interest is his illustration of a cheliceral file-palpal femoral tubercle stridulatory system in these animals corresponding to the type now known in such neocribellates as the Austrochilidae, Gradungulidae, and Mecysmaucheniidae. Other fossil taxa are newly synonymized with extant genera (*Deinopis*, *Hyptiotes*, and *Zygiella*) and families (Heteropodidae, Zodariidae, Dictynidae, Agelenidae, Araneidae, and Oecobiidae). Wunderlich argues that the Clubionidae and Myrmeciidae [=Corinnidae, including the Mymeciinae (=Castianeirinae), Corinninae, and Trachelinae] can be separated by the presence of a rippled cuticular surface in true clubionids; although a few scanning electron micrographs are provided, many more genera must be examined before this distinction, and its polarity, can be assessed.

In Chapter 2, Wunderlich confirms that the Dominican and Baltic amber spiders belong to largely tropical and sub-tropical groups, respectively. The relatively young

Dominican fauna, and the even younger specimens in Dominican copal, resemble current Neotropical assemblages (with only 15% of the genera not occurring in the same place today); in contrast, the Baltic fauna is closer to the present-day Oriental, Ethiopian, and Australian ones (with about three-fourths of the genera extinct in Europe today). Remarkably, a mere eight (out of several hundred) species account for over half of the adult male specimens known in amber.

Chapter 3 is devoted to some Baltic Nesticidae; two species of the fossil genus *Eopopino* are argued to contain two (chrono?) subspecies each, and the genus is suggested as an ancestor of *Carpathonesticus* (raising the spectre of paraphyly). In chapter 4, Wunderlich indicates that "It has not been possible to find a fossil species of spiders in Baltic or Dominican amber which is conspecific with a recent one." Considering the very different findings obtained for some other arthropod groups (such as the Collembola), this result is surprising, particularly for the Dominican taxa. A strong case is made for including Recent European species erroneously assigned to *Tetrilus* and *Tuberta* in the Baltic genus *Mastigusa* instead; the bizarre male pedipalps of these forms are readily observable in the fossils.

Chapter 5 contains the heart of the book—a discussion of araneoid interrelationships that is particularly timely because of the progress recently made in this area by Coddington (1986, which Wunderlich had access to in manuscript form). Eight cladograms are provided, showing various possible arrangements of families and subfamilies, with putative synapomorphies noted. Because no data matrices are supplied, one cannot easily assess the relative parsimony of these alternative arrangements. Wunderlich amplifies Coddington's comments on araneoid-palpi-manoid relationships with a cladogram showing, on one branch, the cribellate orb-weavers (Uloboridae and Deinopidae) and araneoids as sister groups, with Nico-damidae as their outgroup (in a union unsupported by any synapomorphy), and on the other, the Palpimanoidea (in a restricted sense, not that of Forster and Platnick, 1984) and Archaeoidea (including the Micropholcommatidae and more apomorphic families) as sister groups, with the Eresidae as their outgroup (a novel but plausible suggestion). This whole complex is distinguished from the many other araneomorph families only by the loss of all but one metatarsal trichobothrium.

There are several provocative suggestions at the family level as well. Wunderlich continues to include the Hadrotarsidae in the Theridiidae (but without responding to the counter-arguments of Baert, 1984). He elevates the Malkarinae to family status and pairs them (accurately, in my view) with the Mimetidae (indeed, when the entire range of related but still undescribed Australasian taxa is worked up, *Malkara* may prove to be only a highly autapomorphic mimetid). Wunderlich favors retaining mimetids in the Araneoidea, but the only relevant character shown on the two cladograms so constructed is the presence of a basal paracymbium on the male palp. Hence his view primarily raises questions about the homology of "paracymbia" in groups ranging from the Liphistiidae and Hypochilidae on up. Wunderlich offers the first suggestion of a detailed placement for the Cyatholipidae (as the sister group of Nesticidae plus Theridiidae, supported by having the cheliceral teeth slender).

In the more detailed cladograms, Wunderlich differs with Coddington's view of the interrelationships of the three families of tiny and usually lungless araneoids, grouping mysmenids with symphytognathids rather than anapids, and adding (in addition to his unproductive lumping of these families) a novel segregation of the

new taxon Synaphrinae (*Synaphris*, *Cepheia*, and *Iardinis*, with an enlarged pro-marginal cheliceral tooth) from the remaining mysmenids (with a femoral organ, a spur on the male metatarsus I, and denticles between the cheliceral tooth rows). A scheme of interrelationships of ((tetragnathines and leucaugines), metines)), (nephilines, argiopines, (gasteracanthines and araneines))) is rendered somewhat ambiguous by the lack of detailed lists of the genera Wunderlich would place in each of the first three groups (*Zygiella* is also considered a true araneine rather than a member of one of those first three groups). A similar proposal for linyphiid subgroups includes newly named subfamilies at the plesiomorphic end; unfortunately, both Millidge's (1986) new work on linyphiid tracheal systems and the recent establishment of the possibly related Sternodidae (Moran, 1986) were published too late to be included in Wunderlich's analysis.

All in all, Wunderlich has served up a tasty and substantial meal for spider workers to digest; one can only hope that the remaining books in the series will contain an equally palatable stew of paleontological and neontological novelties!—*Norman I. Platnick, Department of Entomology, American Museum of Natural History, New York, New York 10024.*

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## OBITUARY

### Cyril Franklin dos Passos (1887-1986)

Cyril F. dos Passos, the only child of Benjamin Franklin dos Passos and Isabel Kirker Strong, both of New York, was born in New York City on 7 February 1887. He was educated in private schools and then entered New York Law School, graduating with an LL. B. *cum laude* in the spring of 1909. Having been admitted to the Bar of the State of New York in the same year, he practiced law for 19 years, retiring in 1928 to undertake other pursuits. He combined his law work with a very active and highly successful business career, becoming, among other things, the director and president of a southwestern railroad, a holding company, and a brokerage firm.

During this period he married Viola Harriet Van Heis, and they had one son, Manuel. Some years later she unexpectedly died. For many years he was a widower, but on one of his many collecting trips to Europe he met, and subsequently married, in 1959, Maria Amalia Pestana Reis, of Funchal, Madeira. They lived in a French-Norman home near Mendham, New Jersey, that he had built in 1928. Anyone who visited them could not fail to see how well the match turned out, and how much their lives were enriched. During Cyril's final illness she was at his side day and night.

Having retired at the age of 42, he had many options for the future. Many of his interests were in natural history: archaeology, geology, ornithology, paleontology, and entomology. In addition, a very large stamp collection was amassed, and dos Passos published over 20 articles on this subject in various philatelic journals.

Within a year of retiring from his law practice, he decided to specialize in entomology. About 1930 Cyril became acquainted with Dr. Frank E. Lutz, curator in the Department of Insects and Spiders (now Entomology) at the American Museum of Natural History. At that time the museum's butterfly collection was not very extensive and was in disarray; dos Passos began working to remedy this situation. In 1930 he was appointed a Research Associate of this Department, a position he held until 1985. This was followed, in 1952, by a similar title bestowed by the Carnegie Museum; this may have been the first time that one person held that position on the staff of two museums simultaneously.

Cyril brought a new perspective to the collections and collecting of Lepidoptera. Among other things, he realized that one of the basic needs was to accumulate more material and information. He began to employ collectors, for both the museum's and his own collection, to acquire specimens from previously uncollected areas. He was instrumental in bringing a number of collections to New York; one of the first, in which he was a participant, was Jeane Gunder's butterfly collection of some 28,000 specimens, including many primary types. This was followed, through the years, by quite a few more. Concomitantly, he was independently building what was to become the largest North American butterfly collection in private hands; this was supplemented by Palearctic specimens, many of which dos Passos collected himself on numerous trips to western Europe. When donated to the American Museum in 1980 this collection numbered over 65,000 specimens, with practically every one spread and with locality data.

Early on, Cyril came to appreciate the importance of type specimens, and was surprised to find that no one had made a collection of photographs of the types of



the Nearctic butterflies. To remedy this situation, he devised a portable photographic apparatus, and then visited the important type depositories in North America, the British Museum (Natural History), and the Paris Museum in order to accomplish this task. His results are deposited in the Department of Entomology of the American Museum.

In addition to these photographs, he realized the importance of zoological nomenclature, and attended several meetings of the International Congresses of Zoology and Entomology between 1948 and 1956, presenting papers on various subjects. With his legal and entomological backgrounds, he was able to contribute to the formulation of the International Code of Zoological Nomenclature. Thus he was instrumental, in considerable part, for the modernization of the North American butterfly nomenclature.

Still another facet of this multitalented person was his great interest in books; he accumulated one of the most important entomological libraries in private hands—in fact, it was more extensive than the majority of entomological libraries. This collection, including many extremely rare books, as well as complete runs of most current American, English, and many French entomological journals, was donated to Wittenberg University, Springfield, Ohio. In 1961, because of his interest in this field, he was appointed Chairman of the Advisory Committee, Friends of the American Museum Library, and devoted considerable time to that library and its problems.

Dr. dos Passos (his honorary Doctorate in Science was conferred by Wittenberg University in 1965) published some 114 papers, appearing in 22 different journals on three continents. (A listing of these is to appear in the *Journal of the Lepidopterists' Society*.) These papers were on a wide variety of subjects, such as the early stages of some butterflies, nomenclature, bibliography, biography, taxonomy, and the like.

Cyril was a prime mover in founding the Lepidopterists' Society, and he drafted its constitution and by-laws, and was a charter member and honorary life member. He was a principal organizer of the first annual meeting of the society, held in December, 1950, at the American Museum of Natural History. (I know I certainly appreciated all his help.)

After a prolonged illness, this multitalented man died on October 29, 1986, at his home in Mendham, just a few months before his 100th birthday.—*Frederick H. Rindge, Department of Entomology, American Museum of Natural History, New York, New York 10024.*

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The *Journal of the New York Entomological Society* is devoted to the advancement and dissemination of knowledge of insects and related taxa. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie. The Journal will consider for publication manuscripts of any length dealing with original research in entomology. Longer papers will be printed as articles, shorter ones as "scientific notes." Book reviews will be solicited by the Book Review Editor.

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**THE SEASONAL OCCURRENCE OF *IXODES DAMMINI* AND  
*IXODES DENTATUS* (ACARI: IXODIDAE) ON BIRDS  
IN A LYME DISEASE ENDEMIC AREA OF  
SOUTHEASTERN NEW YORK STATE**

GERTRUDE R. BATTALY, DURLAND FISH,<sup>1</sup> AND ROBERT C. DOWLER

Department of Biological Sciences, Fordham University,  
Bronx, New York 10458

**Abstract.**—A total of 310 birds of 41 species were examined for ticks during a 1 year study in a Lyme disease endemic area located in Westchester County, New York. Ticks were found on 28% (88) of the birds and 46% (19) of the species sampled. All of the 231 ticks found were immatures and all but 4 were either *Ixodes dammini* Spielman, Clifford, Piesman, and Corwin (51%) or *I. dentatus* Marx (47%). From May until September, *I. dammini* parasitized 36% of the birds of species found to host ticks and *I. dentatus* parasitized 26% from September to June. Based on the prevalence and seasonal distribution of ticks on birds at this site, we suggest that birds may be important in local and long-distance dispersal of *I. dammini* and thus also possibly important in the dispersal of the etiologic agent of Lyme disease.

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Lyme disease, first recognized in the northeastern United States in Lyme, Connecticut (Steere et al., 1977), is caused by a spirochete, *Borrelia burgdorferi*, which is transmitted to humans primarily by the bite of an ixodid tick, *Ixodes dammini* Spielman, Clifford, Piesman, and Corwin (Burgdorfer et al., 1982; Spielman et al., 1985). This tick parasitizes a broad range of vertebrate species in the northeastern United States, particularly in its immature stages (Anderson and Magnarelli, 1980, 1984; Carey et al., 1980; Magnarelli et al., 1984; Main et al., 1982).

The intent of this study was to explore the role of birds as dispersal agents of ticks, particularly *I. dammini*, and consequently the etiologic agent of Lyme disease—*B. burgdorferi*—in a Lyme disease endemic area. Studies in Connecticut (Main et al., 1982; Anderson and Magnarelli, 1984) and Long Island (Good, 1973) have determined the presence of *I. dammini* on birds. However, none of these studies were conducted continuously throughout the year and none specifically addressed the movement of birds during all periods when they are parasitized by ticks. Our objectives were to determine what tick species parasitize birds in our area and what life stages of ticks are most prevalent on birds. We also studied the seasonal occurrence of tick species and stages hosted by birds and related this to bird movement. In addition, we ascertained if spirochetes were present in samples of ticks removed from birds.

**MATERIALS AND METHODS**

The study was conducted at the Louis Calder Conservation and Ecology Study Center of Fordham University, located in Armonk, Westchester County, New York.

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<sup>1</sup> Medical Entomology Laboratory, Division of Infectious Diseases, Department of Medicine, New York Medical College, Valhalla, New York 10595.

Hundreds of cases of Lyme disease in humans have been reported in the county since 1982 (Williams et al., 1986), including the Armonk site.

Fieldwork was conducted for 67 days between 15 May 1984 and 13 May 1985, averaging 5.5 days per month. Only during January were collections made less than one day per week. Birds were captured with Japanese mist nets and ground traps (McClure, 1984). Two nets were located in mature woodland, 4 at woodland ecotones, 3 in a late successional meadow, and 2 at winter feeder sites. Six ground traps were baited with bird seed and placed along roadsides in summer and at feeder sites in winter. Birds were banded and examined for ticks using 3.5× bifocal headgear. Ticks were removed with forceps from inside the ears and from areas around the eyes, bill, neck, and ears. Ticks were either preserved in 70% ethanol for later identification or were maintained alive for one to three days for spirochete examinations. Forty-one ticks were examined for spirochetes using dark-field microscopy (Anderson et al., 1983).

The mean number of ticks per bird was computed for the year for each bird species found parasitized by ticks (host species). Also, the mean number of ticks per bird was computed semi-monthly for all birds of host species. Bird species for which no parasitized individuals were found are excluded from these computations.

The common names for birds conform to the American Ornithologists' Union checklist (AOU Check-list Committee, 1982). Voucher specimens of ticks have been deposited at the American Museum of Natural History (*Ixodes*) and the Smithsonian Institution (*Dermacentor*).

## RESULTS

A total of 251 birds of 41 species were examined, representing 310 captures and recaptures. Eighty-eight birds of 19 species were found to host ticks. This represents 28% of the total number of birds examined and 32% of 268 captures of host species. A total of 231 ticks representing 4 species were found parasitizing birds: *I. dammini*, *I. dentatus* Marx, *Haemaphysalis leporispalustris* Packard, and *Dermacentor variabilis* Say. This includes 117 *I. dammini* (40 larvae and 77 nymphs) and 110 *I. dentatus* (92 larvae and 18 nymphs). Table 1 shows species of birds hosting larval or nymphal *I. dammini* or *I. dentatus*. Not shown in Table 1 are three larval *H. leporispalustris* collected from one Swainson's Thrush and one larval *D. variabilis* found on a Gray Catbird. No adult ticks of any species were found on birds.

For all bird captures throughout the year, 54 (17%) hosted *I. dammini* and 39 (12%) hosted *I. dentatus*. For birds of host species only, 20% of the birds were parasitized by *I. dammini* and 15% by *I. dentatus*. However, from 1 May to 30 September, *I. dammini* were present of 36% of the birds of host species. Likewise, *I. dentatus* were present on 22% of the birds of host species from 1 March to 30 June and on 32% from 15 September to 31 December. Twenty-two bird species examined were without ticks (Table 2).

*I. dammini* larvae occurred on birds from May through September with a maximum average of 1.3 larvae per bird (of host species) recorded in late August. Nymphs occurred from May through July with a peak of 1.9 nymphs per bird in June (Fig. 1). *I. dentatus* larvae parasitized birds from March through May and from September through December, with peak mean values of 1.1 larvae per bird in April and 3.6

Table 1. Species of birds with *Ixodes* ticks (*Ixodes*) collected at Armonk, New York, May 1984–May 1985.

Species	Total birds (N)	Birds with ticks	Mean (standard error) ticks per bird			
			<i>I. dammini</i>		<i>I. dentatus</i>	
			Larva	Nymph	Larva	Nymph
Blue Jay	12	8	0	0.17 (0.11)	0.67 (0.19)	0.17 (0.17)
Black-capped Chickadee	66	6	0.05 (0.03)	0.02 (0.02)	0.09 (0.06)	0
Tufted Titmouse	25	6	0.08 (0.08)	0	0.32 (0.17)	0
Veery	1	1	0	0	2.00	0
Wood Thrush	13	7	0.31 (0.17)	0.23 (0.12)	0.08 (0.08)	0
American Robin	19	10	0.11 (0.11)	2.00 (0.88)	0.26 (0.21)	0.84 (0.51)
Gray Catbird	51	17	0.27 (0.12)	0.47 (0.16)	0.04 (0.03)	0
Blue-winged Warbler	1	1	1.00	0	0	0
Ovenbird	4	2	0.75 (0.75)	0	0.25 (0.25)	0
Canada Warbler	2	1	1.00 (1.00)	0	0	0
Northern Cardinal	2	1	0	0	1.50 (1.50)	0
Rose-breasted Grosbeak	5	3	0	0.60 (0.24)	0	0
Rufous-sided Towhee	3	1	0.67 (0.67)	0	0	0
Chipping Sparrow	15	6	0.33 (0.16)	0.13 (0.09)	0	0
Song Sparrow	12	7	0.08 (0.08)	0	1.33 (0.67)	0
White-throated Sparrow	8	6	0	0	5.00 (1.65)	0
Brown-headed Cowbird	1	1	0	2.00	0	0
House Finch	26	3	0.04 (0.04)	0.08 (0.05)	0	0
Total (18 species)	266	87				

larvae per bird in October. Nymphs occurred in May and June with a peak of 0.7 nymphs per bird in June (Fig. 1). Eight birds were hosts to both tick species simultaneously. Three birds had both larval and nymphal *I. dammini* simultaneously, and 2 birds had acquired larvae upon recapture within 30 days after hosting nymphs.

Thirty-six *I. dammini* (31 nymphs, 5 larvae), collected from June through August, and 5 *I. dentatus* larvae, collected in October, were examined for spirochetes. The ticks were removed from 20 birds of ten species, with 4 American Robins, and 5 Gray Catbirds hosting 24 of the 36 *I. dammini* nymphs. The remaining *I. dammini* were removed from 1 Blue Jay, 2 Black-capped Chickadees, 1 Tufted Titmouse, 1 Chipping Sparrow, 1 Song Sparrow, 1 Brown-headed Cowbird, and 2 House Finches. The *I. dentatus* were removed from 2 White-throated Sparrows. Six *I. dammini* nymphs from 3 American Robins were found to contain spirochetes, including 1 of 5 nymphs collected from a male on 14 June, 2 of 4 nymphs collected from a female on 20 June, and all 3 of the nymphs collected from a female on 13 July. No spirochetes were found in the sample of *I. dentatus*. However, spirochetes were found in a questing *I. dentatus* nymph collected during a concurrent study at the Armonk site (unpublished data).

#### DISCUSSION

Among the bird species with sample size of 10 or more, those parasitized by ticks most frequently include Blue Jay, Wood Thrush, American Robin, Gray Catbird,



Table 2. List of bird species found not to host ticks.

Species	Number examined
Mourning Doves	3
Black-billed Cuckoo	1
Ruby-throated Hummingbird	1
Eastern Wood-Pewee	1
Least Flycatcher	1
White-breasted Nuthatch	4
Ruby-crowned Kinglet	1
Brown Thrasher	1
Yellow Warbler	2
Magnolia Warbler	3
Black-throated Blue Warbler	1
Black and White Warbler	3
American Redstart	3
Worm-eating Warbler	1
Louisiana Waterthrush	1
Common Yellowthroat	1
Scarlet Tanager	1
Swamp Sparrow	1
Dark-eyed Junco	7
Northern Oriole	3
American Goldfinch	1
House Sparrow	1
Total (22 species)	42

Chipping Sparrow, and Song Sparrow (Table 1). These species are frequently found foraging on or near the ground. The absence of ticks from 22 species of birds may simply reflect small sample sizes or sampling during periods of low tick activity (Table 2). However, some species might not normally be parasitized due to ecological factors, such as infrequent occurrence of the bird at tick questing elevations or in appropriate habitats.

*I. dammini* comprised the majority (51%) of the ticks found parasitizing birds at this site. In a similar study conducted on Long Island, New York, Good (1973) found *I. dammini*, misidentified as *I. muris* (Spielman et al., 1979), to comprise 96% of the ticks found on birds. Also, Anderson and Magnarelli (1984) reported *I. dammini* to comprise 91% of the ticks found on birds in a Lyme disease-endemic area of Connecticut. Neither of these studies was continued into late October when peak numbers of *I. dentatus* larvae occur (Fig. 1).

In contrast, Sonenshine and Clifford (1973) found *H. leporispalustris* to be the dominant (57%) tick species parasitizing birds sampled from 11 banding locations operated along the eastern U.S. coast between 1965 and 1968. Similarly, Snetsinger et al. (1970) found this species almost exclusively (95–99%) on birds sampled in Ocean Co., New Jersey from 1965 to 1968. It is interesting that *I. dammini* (as *I. scapularis* or *I. muris*) was not reported in either of these earlier studies. Lyme disease is now endemic in Ocean Co., New Jersey and in 2 of the areas (Long Island, NY

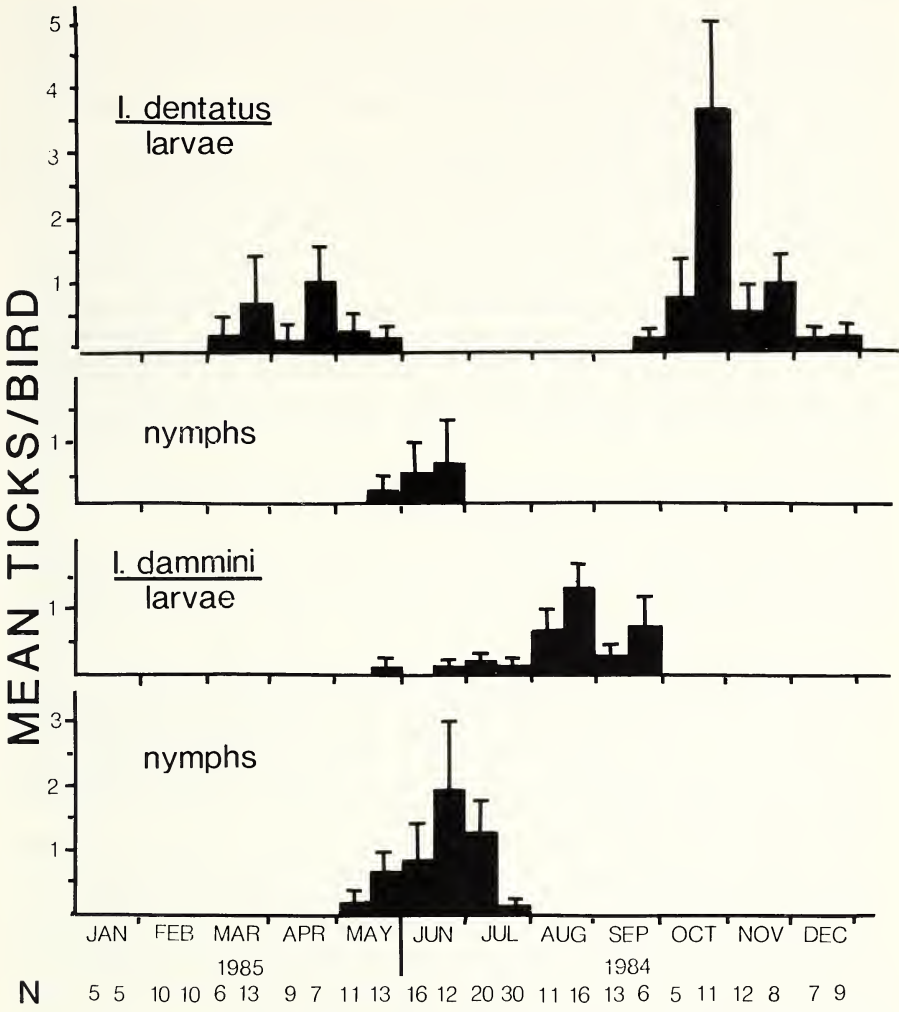


Fig. 1. Bi-monthly means (and standard error bars) of *I. dammini* and *I. dentatus* found on birds at Armonk, New York (N = sample size).

and Cape May, NJ) sampled by Sonenshine and Clifford (1973) (Hanrahan et al., 1984; Schulze et al., 1984).

The collection of a larval *D. variabilis* from a Gray Catbird is, to our knowledge, a new host record. Sonenshine and Stout (1970) found no *D. variabilis* on over 10,000 birds examined in North Carolina and over 700 birds examined in Virginia.

The seasonal occurrence of *I. dammini* on birds observed in this study closely parallels that which has been reported for mammals (Anderson and Magnarelli, 1980, 1984; Carey et al., 1980; Magnarelli et al., 1984). Data on the seasonal occurrence

of *I. dentatus* larvae vary somewhat from those of Sonenshine and Stout (1970) and Sonenshine and Clifford (1973) for the Piedmont and coastal areas of the eastern United States. In these studies nymphs occurred in April and May whereas in our study they occurred from late May through June. This delay may be due to the latitudinal difference between the sites.

Our data support the contention that birds may play an important role in local and long-distance dispersal of *I. dammini* and possibly also the causative agent of Lyme disease. During the breeding season, dispersal of *I. dammini* by birds may be limited to the breeding territory for most avian species. This territory varies in size within and among bird species. For example, territories of 0.4 to 1.2 ha for Gray Catbirds, 0.8 to 1.2 ha for Rose-breasted Grosbeaks, 0.2 to 0.6 ha for Song Sparrows and Chipping Sparrows, and 0.3 to 1.7 ha for Ovenbirds, have been reported (Stokes, 1979; Welty, 1979). Birds which might disperse *I. dammini* beyond confined breeding areas include Blue Jays, which do not have well-defined territories, and American Robins, which feed and roost extensively outside small nesting territories (Bent, 1949; Stokes, 1979).

After the breeding season, dispersal of *I. dammini* by migrating birds would be confined to the larvae because nymphs do not occur on birds after July and migration does not begin until August. Host species that migrate during the peak larval period are Blue-winged Warbler, Canada Warbler, Gray Catbird, and Rose-breasted Grosbeak (Bull, 1964). During the last 2 weeks of August, 3 of the 4 catbirds captured at the study site were hosts to larval *I. dammini*, with a mean load of 2.25 larvae per bird and a maximum of 5 larvae on one bird. Species migrating in September, when the larvae are still prevalent on birds, include the Veery, Swainson's Thrush, Ovenbird, Rufous-sided Towhee, Brown-headed Cowbird, and Blue Jay (Bull, 1964; Dolbeer, 1982; Treacy, 1985). These migration periods allow the southward dispersal of *I. dammini* larvae and may account for its apparent spread southward along the east coast (Spielman et al., 1984; Schulze et al., 1984).

Spring migration of birds would facilitate the northward dispersal of *I. dammini*. Nymphs begin to occur on birds in early May and increase in number throughout the migration period. In this study, host species which migrate in May include Ovenbird, Gray Catbird, and Rose-breasted Grosbeak. Veery, Wood Thrush, and Blue-winged Warbler are considered rare in New York State before May (Bull, 1964). Canada Warbler and Swainson's Thrush are likewise rare before mid-May with the latter migrating as late as early June (Bent, 1949; Bull, 1964).

In isolating *B. burgdorferi* from the liver of a Veery, Anderson et al. (1986) have demonstrated that birds may be suitable reservoirs for the Lyme disease spirochete. They indicated that infected larval *I. dammini*, which were removed from 6 species of birds, probably acquired the spirochetes from these hosts. The prevalence and seasonal occurrence of *I. dammini* on birds in our study suggests that the opportunity for horizontal transmission of *B. burgdorferi* to the next generation of *I. dammini* may be great because nymphs occur on birds both prior to and concurrent with larvae. Such horizontal transmission involving vertebrate reservoirs is essential for the maintenance of the spirochete in nature, but currently this role is attributed to the white-footed mouse, *Peromyscus leucopus* (Levine et al., 1985).

Birds would be important in introducing *B. burgdorferi* into new areas if they serve as reservoirs or if the spirochete can be acquired transovarially. Recent evidence

suggests that transovarial transmission of *B. burgdorferi* occurs rarely in *I. dammini* in nature (Piesman et al., 1986; Magnarelli et al., 1987). Spring migration of birds probably would be less important than fall migration because mostly nymphs are transported in the spring and these will parasitize medium-sized or large mammals after molting to adults. This may not result in the establishment of spirochetes in new areas, because most adults are temporally separated from immatures. Establishing new disease foci may require the dispersal of infected larvae which would occur during the fall migration. Only one larva was observed in the examination of forty birds of host species from 1 May to 15 June which suggests that northward dispersal of *B. burgdorferi* by *I. dammini* on birds would be minimal.

The presence of spirochetes in an *I. dentatus* nymph from a Lyme disease endemic area, together with the presence of larval *I. dentatus* on birds during spring migration, when nymphal *I. dammini* occur, would be significant if *I. dentatus* were a competent vector for *B. burgdorferi*. However, a mean of 0.3 larval *I. dentatus* per bird in May compared with 1.3 larval *I. dammini* per bird in late August would still result in a slower dispersal northward than southward.

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## FLIGHT ACTIVITY OF *NEOCURTILLA HEXADACTYLA* (PERTY) (ORTHOPTERA: GRYLLOTALPIDAE): ASYNCHRONOUS MOBILE POPULATIONS?

HAROLD G. FOWLER, VALDEMAR R. ORTEGA,<sup>1</sup> AND LUIZ LUCCAS TEIXEIRA<sup>1</sup>

Instituto de Biociências, Universidade Estadual Paulista,  
UNESP, 13500 Rio Claro, São Paulo, Brazil

**Abstract.**—Flying mole crickets, *Neocurtilla hexadactyla* (Orthoptera: Gryllotalpidae) were attracted to light traps in Promissão, São Paulo, Brazil. Flights were strong throughout the year, peaking in June. Females significantly outnumbered males during the entire year. Females were generally reproductively mature, suggesting that populations do not develop synchronously. Data from Venezuela also fit this pattern, while data from Uruguay and other locations in São Paulo state, are characterized by annual periodicity of flight activity and a reduced number of crickets trapped, which is characteristic of univoltine, synchronously developing populations.

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Many insect species are attracted to lights, but the reasons for this behavior are still unknown. Often, when large numbers of a particular insect species are attracted to lights, these species are considered pests. In the New World, the mole cricket *Neocurtilla hexadactyla* can be locally abundant and be attracted to lights in large numbers. This paper reports on the flight activity and reproductive condition of *N. hexadactyla* in Promissão, São Paulo, Brazil. These data are compared with data from Venezuela (Doreste, 1975), as well as from other locations throughout the Neotropics. They are used to infer certain life history traits of these crickets and to compare flight activity in *N. hexadactyla* with other mole cricket species.

### METHODS AND MATERIALS

A modified Pennsylvanian light trap (Frost, 1957) fitted with an incandescent neon light, was placed in the field near a pasture-forest interface on the station grounds of the Companhia Energetica de São Paulo (CESP) in Promissão, São Paulo, Brazil. The trap was run 3 nights weekly during the entire year of 1984. Collected crickets were preserved in alcohol and taken to the laboratory, where they were sexed. All females per bi-weekly sample were dissected, and ovarian development was noted.

### RESULTS

During all times of the year, flight activity monitored by light traps was recorded for *N. hexadactyla* in Promissão, São Paulo (Fig. 1). Flight activity was most pronounced from February through June, corresponding to a tropical summer through fall. The sex ratio was strongly skewed in favor of females (Fig. 1), and annually this bias is highly significant ( $P = 0.001$ ). The percentage of females with eggs present was high throughout the year (Table 1). All females without eggs had large fat bodies.

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<sup>1</sup> Companhia Energética de São Paulo—CESP. 01310 São Paulo, SP, Brazil.

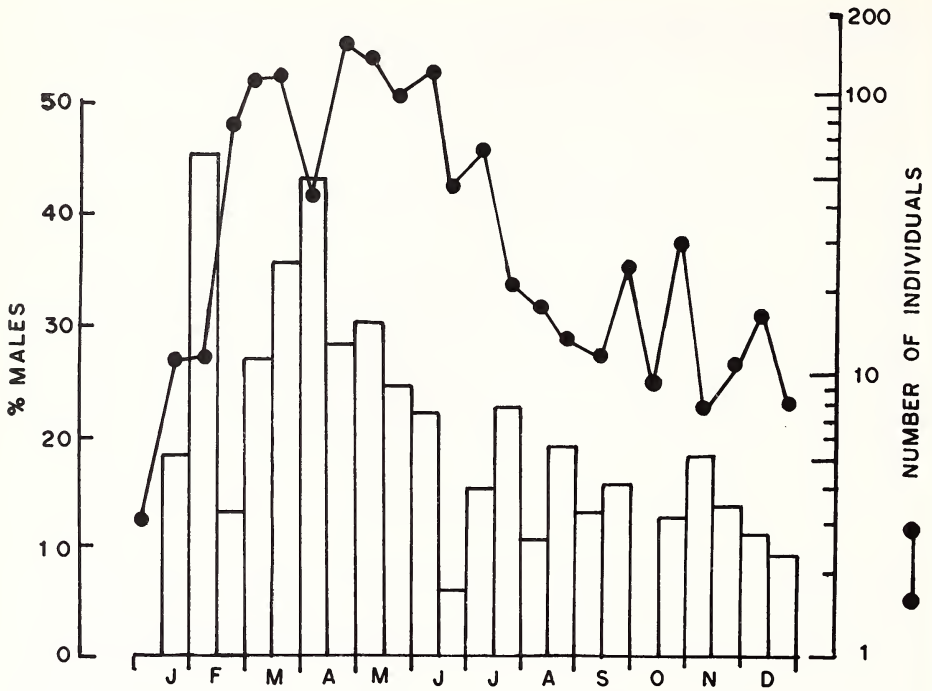


Fig. 1. Bi-weekly (3 trapping nights/week) captures at light traps of *Neocurtilla hexadactyla* in Promissão, São Paulo, as well as the respective percentage of males captured.

#### DISCUSSION

The numbers of *N. hexadactyla* captured at light traps during this study suggest that the population from which these crickets came was large. These data are unlike flight data for species of exotic mole crickets of the genus *Scapteriscus* in the United States (Ulagaraj, 1975; Walker et al., 1983; Fowler, 1987). These *Scapteriscus* species generally have a discrete annual peak of flight activity with often a second period of flight activity later in the year. This pattern occurs also in South American *Scapteriscus* (Fowler, 1987). A similar pattern in annual flights was recorded for *N. hexadactyla* in Venezuela (Doreste, 1975) (Fig. 2). The differences of annual peaks, September–December for Venezuela and January–April for São Paulo, easily fit a clinal model of flight periodicity (Fowler, 1987), explained solely by latitude. For other populations in the state of São Paulo, Brazil, and in Montevideo, Uruguay, however, only a late spring–early summer peak was found in light trap catches, with flying crickets not being registered for most of the year (Fowler, 1987).

During the entire year, females outnumbered males in the light trap catches, suggesting a skewed sex ratio in the population studied. As with all crickets, the males are relatively less mobile and captures of females always predominate (Alexander, 1968). A greater percentage of females also has been recorded for light trap captures of *Scapteriscus* mole crickets (Ulagaraj, 1975), light trap captures of *Gryllus integer* Scudder (Cade, 1979), pitfall trap captures of *Gryllus rubens* Scudder (Veazey et al.,

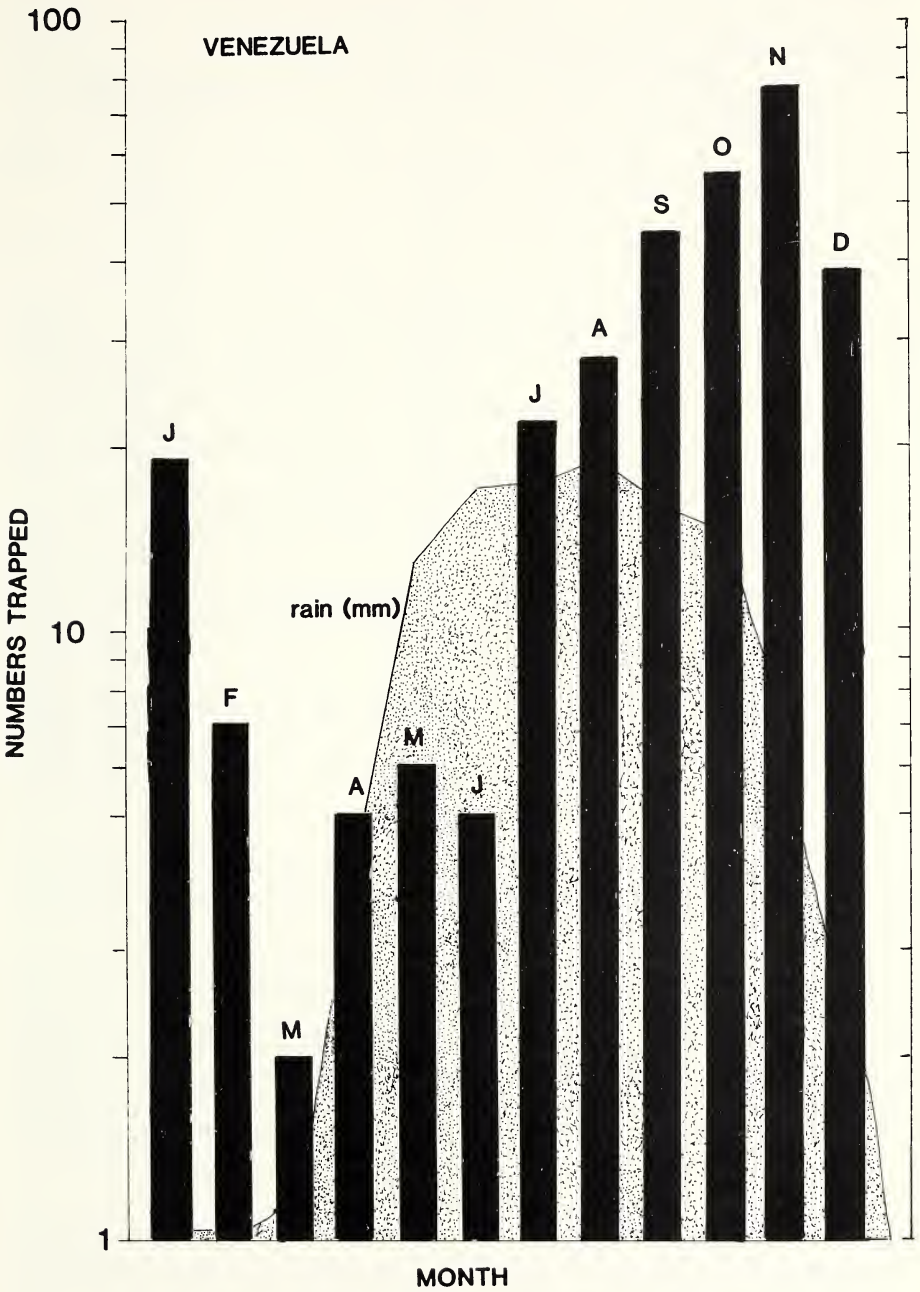


Fig. 2. Monthly catches of *Neocurtilla hexadactyla* at light traps in Cagua, Venezuela, as well as the respective precipitation. After Doreste (1975).



Table 1. Bi-weekly samples of female *Neocurtilla hexadactyla* collected at light traps indicating the percentage of well formed eggs in the reproductive tract.

Month (1984)	Bi-weekly sample	% females with eggs
January	01	86.7
	02	80.0
February	03	93.3
	04	83.3
March	05	100.0
	06	96.7
April	07	100.0
	08	93.3
May	09	100.0
	10	76.7
June	11	60.0
	12	100.0
July	13	93.3
	14	73.3
August	15	66.7
	16	86.7
September	17	93.3
	18	100.0
October	19	70.0
	20	83.3
November	21	76.7
	22	100.0
December	23	93.3
	24	96.7

1976), and sound-trap captures of *Scapteriscus* mole crickets (Ulagaraj and Walker, 1973). For many insect species, a female-biased sex ratio is characteristic in dispersal studies (Johnson, 1969).

Due to the large numbers of flying crickets throughout the year, dominated by gravid females, it appears unlikely that populations develop synchronously, as has been reported for other mole crickets (Ulagaraj, 1975). Dispersal by flight is important in the colonization of suitable habitats by mole crickets (Ulagaraj, 1975), and therefore adaptive (Kennedy, 1975). Studies of dispersal have generally focused on synchronously developing populations (Kennedy, 1975), but, as these data indicate, dispersal may also be important for asynchronously developing, highly mobile populations.

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**FIELD BEHAVIOR OF *EUPHASIOPTERYX DEPLETA*  
(DIPTERA: TACHINIDAE): PHONOTACTICALLY ORIENTING  
PARASITIDS OF MOLE CRICKETS  
(ORTHOPTERA: GRYLLOTALPIDAE: *SCAPTERISCUS*)**

HAROLD G. FOWLER

Instituto de Biociências, Universidade Estadual Paulista,  
(UNESP), 13500 Rio Claro, São Paulo, Brazil

*Abstract.*—Using direct observation and sticky trap captures, larvipositing female *Euphasiopteryx depleta* were studied in central Brazil. Females were attracted by phonotaxis to sound traps that broadcast synthesized calling songs of *Scapteriscus* mole crickets. Mean permanency at sound traps during larviposition was less than 3 secs, with females orienting upwind to sound sources in windy conditions. Data suggest that *E. depleta* populations are highly mobile, with activity periods corresponding to mole cricket calling periods. The number of females attracted to sound traps varied with respect to broadcast sound intensity.

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Five species of *Scapteriscus* mole crickets have been accidentally introduced into the Caribbean and southeastern United States (Nickle and Castner, 1984). Of these species now present in the U.S., *Scapteriscus vicinus* Scudder has been shown to be a significant economic pest (Walker and Ngo Dong, 1982), although the other introduced species are also known to produce unquantified economic damage. Due to the Neotropical distribution of *Scapteriscus*, efforts to identify natural enemies of mole crickets in South America might identify potential biological control agents.

Among the likely control agents for importation into the Caribbean and U.S. are tachinid flies of the genus *Euphasiopteryx*. Wolcott (1940) reported rearing *E. depleta* (Wied) from an unidentified *Scapteriscus* in Belém, Pará, Brazil. In the U.S., the related species *E. brevicornis* (Tocon.) is a parasitoid of *Neoconocephalus robustus* (Scudder) (Nutting, 1963), while *E. ochraceae* (Bigot) has also been attracted to the calling songs of *Gryllus integer* Scudder and to larviposit in their vicinity (Cade, 1975). Mangold (1978) found that *E. ochraceae* was also attracted to the synthesized broadcast calls of *Scapteriscus acletus* Rehn and Hebard, and he was able to rear *E. ochraceae* from this mole cricket under experimental conditions. In Paraguay, *E. depleta* has been attracted to the synthesized broadcast songs of *S. acletus* (Fowler and Kochalka, 1985). Furthermore, *E. depleta* has been reared from three species of field collected *Scapteriscus*, and has been reared from *Scapteriscus* in laboratory experiments (Fowler and Garcia, 1987).

This paper reports on observations of the behavior of *E. depleta* females in the field, as monitored through observations and captures of these phonotactically orienting flies at broadcast sound sources. Data on periods of calling activity of mole crickets, and dissections of captured *E. depleta* females, are used to infer further aspects of their biology.

**METHODS AND MATERIALS**

Most of the observations recorded here were made in Rio Claro, state of São Paulo, Brazil, from July 1984 through July 1986. At one site in Rio Claro (Chacara Betânia),

Table 1. Monthly captures of *E. depleta* females with sticky traps mounted over sound traps broadcasting synthesized songs of *Scapteriscus* mole crickets in Rio Claro, São Paulo, Brazil, during 1985–1986.

Month of year	Number of female <i>E. depleta</i> captured at			Total
	<i>S. vicinus</i>	<i>S. borellii</i>	<i>S. imitatus</i>	
January	97	32	37	166
February	16	8	10	34
March	7	5	4	16
April	0	0	0	0
May	0	0	1	1
June	4	6	1	11
July	2	3	4	9
August	5	3	0	9
September	1	0	0	1
October	21	17	19	57
November	49	22	20	93
December	75	38	47	160
Sum	277	134	143	554

three sound traps (Walker, 1982), broadcasting synthesized calls of *S. borellii* Giglio-Tos (= *S. acletus*), *S. vicinus* Scudder, and *S. imitatus* Nickle and Castner, were run nightly throughout the year. Each sound trap was located 50 m away from its neighbor and covered with a plastic bag coated with Tanglefoot® on which attracted and landing *E. depleta* females were trapped. The locations of each trap were changed daily to minimize the effects of location on the numbers of *E. depleta* trapped. These data were used to determine the relative attractiveness of each species synthesized call to *E. depleta* and to monitor the seasonal abundance of host seeking females.

During periods of peak captures, the landing distribution of *E. depleta* females was determined by plotting their position on sticky traps relative to the center of the sound source. Landing distributions were also plotted during nights with wind velocities of 10 km/hr<sup>-1</sup> or more, at which time the direction of the wind was recorded. Female *E. depleta* from three nightly catches at *S. borellii* sound traps, and from 13 nightly catches at *S. vicinus* sound traps, were dissected in the laboratory, and the larval complement of each female was recorded.

On the campus of the Universidade Estadual Paulista, approximately 7 km distant from the first site, another series of field observations was undertaken. During peak activity (December 1984–January 1985), taped synthesized calls of *S. vicinus*, *S. imitatus*, *S. borellii*, *S. didactylus* Scudder, and *Neocurtilla hexadactyla* Perty were simultaneously broadcast during 10 non-consecutive nights, and the number of *E. depleta* trapped on sticky plastic bags was recorded. During the remaining 50 days, 2 sound traps broadcasting *S. vicinus* synthesized songs and 2 sound traps broadcasting *S. borellii* synthesized songs were used daily. Sound traps broadcast approximately 100 db at full intensity. One of the sound traps broadcasting the call of each species was run at this intensity while the other broadcast at ¼ full intensity (Watts) as measured by a potentiometer. As before, the locations of each of the 4 traps were changed each night. Female *E. depleta* were captured with sticky traps as before, and



Table 2. The effects of sound intensity of broadcast synthesized calls of *Scapteriscus* mole crickets on the capture of female *E. depleta* (paired tests).

Synthesized <i>Scapteriscus</i> broadcast call	Broadcast call intensity (Watts)	Number of <i>E.</i> <i>depleta</i> captured	G	P
<i>S. borellii</i>	full	51	81.85	<0.05
	¼	19		
<i>S. vicinus</i>	full	121	234.32	<0.05
	¼	62		

their temporal activity was monitored by recording catches every 30 min. These data were then compared with the flight activity data of *S. vicinus* (A. Silveira-Guido, unpubl.).

#### RESULTS

Seasonal activity of female *E. depleta* was found to be largely concentrated in the late spring and early summer (Table 1). A significant seasonal variation was found for captures at all sound traps ( $G = 777.39$ ;  $P < 0.05$ ;  $df = 22$ ), but the seasonal distribution of catches was not found to differ significantly between sound sources, using the log-likelihood G statistic (Zar, 1974), for pairwise species comparisons taken month by month (36 comparisons). Based on these captures, the song of *S. vicinus* was approximately twice as attractive to phonotactically orienting *E. depleta* females than either *S. imitatus* or *S. borellii* (Table 1). This result, using total annual capture, was significant ( $G = 65.544$ ;  $P < 0.05$ ).

In the 10 day test using taped synthesized songs, the number of *E. depleta* captured at each broadcast call was 0 for *S. didactylus* and *N. hexadactyla*, 24 for *S. borellii*, 33 for *S. imitatus*, and 51 for *S. vicinus*.

In evaluations of the effect of sound intensity on the number of *E. depleta* attracted (Table 2), full intensity attracted significantly more flies than did ¼ full intensity, for both *S. vicinus* and *S. borellii* broadcast calls ( $P < 0.05$ ).

Using a sound trap broadcasting *S. vicinus* synthesized male calls and a weak red light and digital stopwatch, 20 female *E. depleta* were timed for permanency at the sound. All females arrived and left the sound source in 3 secs or less. During this time, they quickly circled the point source while depositing larvae.

The landing distribution of larvipositing females is shown in Figure 1. During non-windy nights, no significant directionality of landings was observed (Fig. 1), but directionality was significantly downwind during windy nights, using Raleigh's test (Zar, 1974) ( $P < 0.05$ ). A strong unimodal peak of landings was detected 10 to 15 cm from the point sound source, with the resulting landing distribution conforming to a Poisson, using a goodness of fit test (Zar, 1984).

The mean and variance of larval numbers of female *E. depleta* caught during 3 nights at the *S. borellii* sound source was 148.2 and 90.20 respectively (range 32–400,  $N = 30$  females), while for the 13 nightly catches at *S. vicinus* sound sources, the mean was 175.5 and the variance 90.96 (range 28–488,  $N = 111$  females). The daily means and variances were weakly correlated ( $r = 0.63$ ) (Fig. 2). In all cases, the variance was smaller than the mean (Fig. 2).

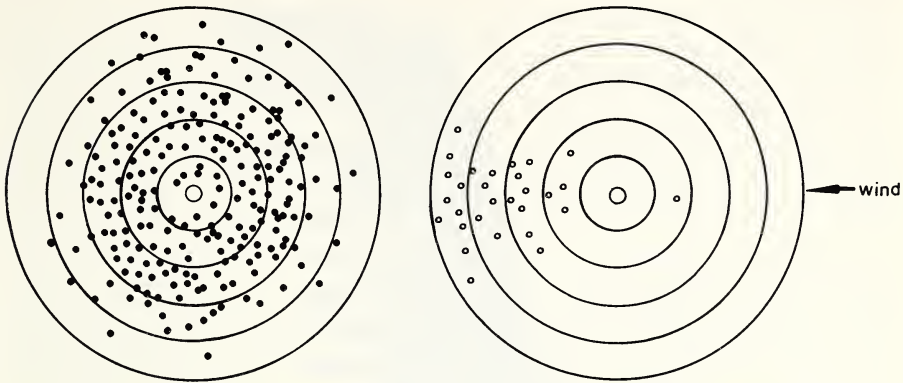


Fig. 1. The landing distributions of female *E. depleta* on sticky traps mounted over sound traps. Each annulus corresponds to 5 cm, with the sound source centered. Distributions of landing females are compared on windy and non-windy nights.

By comparing the flight periods of *S. vicinus* (Fig. 3) with the temporal patterning of captures of *E. depleta* females (Table 3), the proportion of flies captured during mole-cricket flight periods was only 44.3%. However, males call for at least 1.5 hrs after sunset, but much less, and this gives a synchrony of 67.8%.

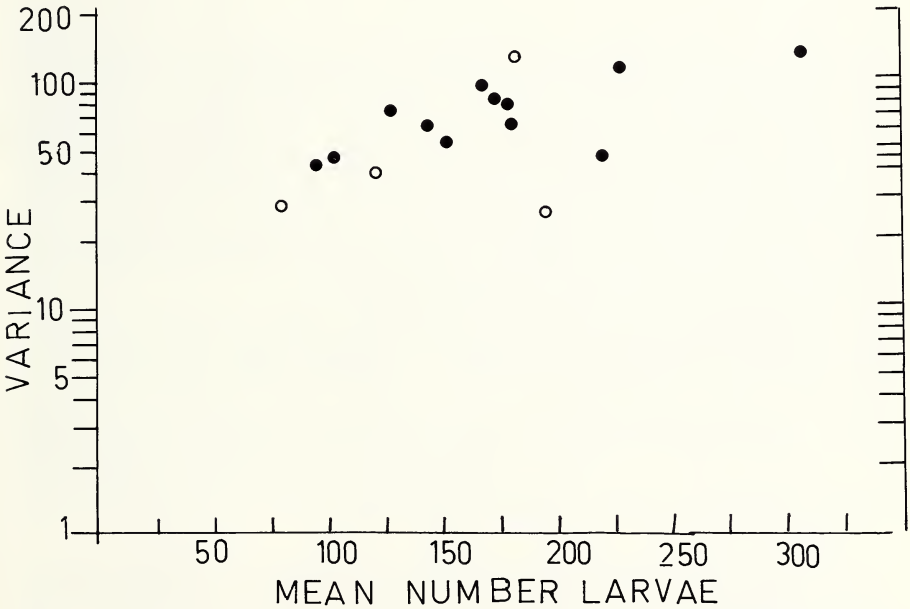


Fig. 2. The mean-variance relation of the number of larvae present in female *E. depleta* on separate capture nights. Open circles = *S. borellii* sound trap, closed circles = *S. vicinus* sound traps.

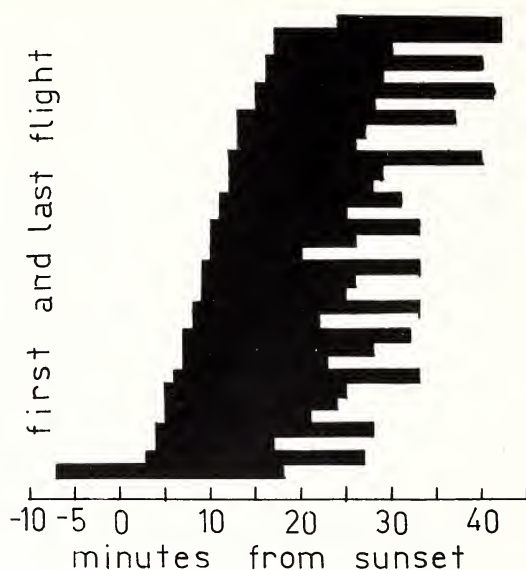


Fig. 3. The timing of first and last flights of *S. vicinus* in Santana do Livramento, Rio Grande do Sul, Brazil. Data furnished by Aquiles Silveira-Guido. Each bar represents one night of observation.

#### DISCUSSION

The results of these observations clarify the potential usefulness of *E. depleta* as a potential candidate for introduction in biological control programs for *Scapteriscus* mole crickets. Large numbers of flies were attracted to the songs of *S. vicinus*, *S. borellii*, and *S. imitatus*, all of which are exotic pests in the Caribbean and southern United States. During this study, no flies were attracted to the synthesized calls of *S. didactylus*, also introduced accidentally into the Caribbean (Nickle and Castner, 1984), nor to the calls of *N. hexadactyla*, a native mole cricket in North and South America. The higher relative preference shown for *S. vicinus* calls is supported by earlier work (Fowler, 1987a; Fowler and Garcia, 1987).

The seasonal activity of *E. depleta* documented by sticky trap captures at sound traps coincides with the seasonal occurrence of dispersal flights in South American *Scapteriscus* (Fowler, 1987b). That *E. depleta* can be captured at other periods, but

Table 3. The number of *E. depleta* captured at sound traps as a function of time of capture.

Hours from sunset	Number of <i>E. depleta</i> captured	Proportion of total
0-0.5	17	0.093
0.5-1.0	64	0.350
1.0-1.5	43	0.235
1.5-2.0	27	0.147
2.0-2.5	9	0.049
2.5	23	0.126
Total	183	1.000

in much lower numbers, suggests that alternative hosts might exist. In fact, *E. depleta* has been reared from field collected *Anurogryllus* sp. (Fowler and Mesa, 1987), as well as from *Scapteriscus abbreviatus* Scudder, a brachypterous species which does not call (Fowler and Garcia, 1987). Moreover, *E. depleta* is an established phonotactically orienting parasitoid of *S. vicinus* (Fowler and Garcia, 1987; Fowler, 1987a, b), and other possibilities could explain field patterns of activity. The diel synchrony of *E. depleta* phonotaxis and *S. vicinus* flight activity adds further support to the role of *E. depleta* as an ideal biological control candidate.

The relatively rapid larvipositional runs of *E. depleta* females at sound traps, as well as the differential response to varying sound intensity, are of special importance. Louder calling male *Scapteriscus* mole crickets have been shown to attract a larger number of dispersing females to their burrows (Forrest, 1980, 1983), and thus would attract greater numbers of *E. depleta* as well. Female mole crickets enter male calling burrows for mating (Forrest, 1980), and by larvipositing at an annulus 10–15 cm from the burrow opening, *E. depleta* larvae would be ideally placed to attach themselves to attracted female mole crickets. It has been shown that this behavior could have a large impact on the mate selection processes in mole crickets (Fowler, 1987d). Male mole crickets could respond by calling in a more discontinuous manner, but even this does not deter the phonotactic ability of female *E. depleta* (Fowler, 1987c).

If sound traps capture all receptive females in a given area, then the normal distribution of the number of larvae per attracted female *E. depleta*, suggests that females are reproductively active over many days and that they are highly mobile. As sound traps fitted with sticky traps have the potential of indeed attracting and capturing all *E. depleta* females within a given area, all resulting catches should demonstrate a very high mean, near 500, and a very small variance, unless new flies were continuously entering the area. Older females, with a lower number of larvae, could only be trapped if they immigrated into the area. This power of dispersion is an additional attribute of *E. depleta*, and suggests that it could track mole cricket populations in the field, and could behaviorally respond to these populations.

Much more needs to be learned about *E. depleta*. For example, nothing is known about male behavior, as males are not attracted to sound sources. Nor is the behavior of females during the day yet known. Further, difficulties have been found in obtaining reproductive maturity in the laboratory with experimentally reared females (Fowler, 1987a). All of these indicate that we still lack a complete understanding of the reproductive behavior and ecology of *E. depleta*. None of these factors, however, lessen the usefulness of *E. depleta* as a potential introduction to control exotic populations of *Scapteriscus* mole crickets. They only indicate that much more research needs to be performed to eliminate these and other impediments for their management and use in biological control programs.

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## TEMPERATURE, CONTACT RATES, AND INTERINDIVIDUAL DISTANCE IN WHIRLIGIG BEETLES (COLEOPTERA: GYRINIDAE)

KEVINA VULINEC<sup>1</sup> AND STEVEN A. KOLMES

Cincinnati Museum of Natural History, 1720 Gilbert Avenue,  
Cincinnati, Ohio 45202, and  
Department of Biology, Hobart and William Smith Colleges,  
Geneva, New York 14456

**Abstract.**—Contract rates between individual stream-dwelling gyrids increased with increasing temperature, while those for pond-dwelling gyrids remained fairly constant. In aggregated pond beetles, interindividual distance increased with increasing temperature up to 21°C, and then declined. These observations may be explained by the different constraints of the two habitats, and the function of whirligig beetle aggregations.

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Beetles of the family Gyrinidae are known for their conspicuous aggregations on the water surface of both ponds and streams. We examined the influence of temperature on the aggregating and contact behavior of whirligig beetles in the two habitats.

Pond- and stream-dwelling *Dineutes* were observed in Iowa County, Wisconsin, in a pond and on a part of the Wisconsin River; both sites were near the town of Arena. The stream gyrids were located in an eddy behind a fallen tree that was half submerged in the river. Observations of pond and stream gyrids were carried out on calm summer days to avoid the complications of choppy waves. Physical contacts that could be identified as part of sexual behavior (Kolmes, 1983a, 1985) are excluded from this data set. Observations were carried out during late morning through early afternoon hours.

In order to measure the rate at which pond- or stream-dwelling gyrids briefly contacted one another, an observer sat motionless approximately 2 to 3 meters from a gyrid swarm. Binoculars (7 × 35 mm) and a stopwatch were used to count and time contacts within the swarm. Small numbers of focal beetles were observed when counting contacts. Water temperature (approximately 1 cm below the surface) was measured immediately after each observation period was terminated. Focal beetles were randomly selected in the swarms. Observation periods were generally of 30 min duration each, occasionally of somewhat more or less time.

In the stream habitat, gyrids maintained a very consistent position within the swarm swimming into the current, aside from the brief “dashes” that resulted in each contact. Because of this spatial stability it was a simple matter to observe contacts as they occurred within a swarm, and to subsequently calculate a contact rate (number of contacts/(number of beetles × number of hours observed)). It is important to realize that these stream-dwelling *D. discolor* were limited to a constrained surface

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<sup>1</sup> Current address: Department of Biology, University of Chicago, Chicago, Illinois 60637.

Table 1. Contact rates and water temperatures for *Dineutes discolor* located on the Wisconsin River. Every contact rate is the mean value for a separate observation period.

Water temp °C	Contact rate
25.0	10.8
25.5	5.4
25.5	7.7
26.0	32.5
26.0	13.3
26.0	40.0
26.0	50.0
26.5	33.3
27.0	18.6
27.0	47.6
28.0	80.0
28.0	99.2

area; they were aggregated in the area of relatively weak current provided by a fallen log near the bank.

The pond gyrinids (a mixture of *Dineutes* spp. other than *D. discolor*—*D. assimilis*, *D. hornii*, and *D. nigrior* all occurred in that area) had no fixed spatial limits to their aggregations; beetles that began to feed actively generally moved to the periphery of the aggregation and swam about in a region of emergent vegetation at the pond margin. Beetles selected for focal observations on the pond were not part of the motionless central clump of individuals that sometimes formed and floated in constant contact with their clump-neighbors. For information about the feeding behavior of pond-dwelling gyrinids, see Heinrich and Vogt (1980).

The water temperatures and contact rates are shown for stream-dwelling *Dineutes* in Table 1, and for pond-dwelling *Dineutes* in Table 2. Two things are immediately apparent in comparing these tables: 1) The contact rates for stream-dwelling gyrinids are generally higher at higher temperatures, while pond-dwelling gyrinids contact one another at a much more consistent rate regardless of ambient temperature. 2) The pond beetle contact rates are all within the contact rate range for river beetles when the river was cool. The pond beetles never achieved the elevated contact rates typical of stream-dwelling beetles at the higher temperatures, despite the fact that for some observation periods water temperatures in the pond exceeded those measured for river water.

If a least squares regression of water temperature and contact rate is calculated, it can be used to produce a coefficient of determination ( $r^2$ ) that expresses the percentage of the variation in contact rates that can be attributed to water temperature (Milton and Tsokos, 1983). The coefficient of determination for water temperature vs. contact rate for stream-dwelling *Dineutes* is 0.706, indicating that 70.6% of the variation in contact rate is accounted for by water temperature variability. For pond-dwelling *Dineutes*, the  $r^2$  value is 0.001, so that only 0.1% of the variation in contact rate is accounted for by water temperature variability. Stream-dwelling *Dineutes* exhibit a linear relationship between temperature and spacing behavior that does not appear to exist among their pond-dwelling congeners.

Table 2. Contact rates and water temperatures for *Dineutes* spp. that inhabit a pond habitat. Every contact rate is the mean value for a separate observation period.

Water temp °C	Contact rate
23.0	22.7
23.0	12.7
23.0	17.0
23.0	18.0
23.5	21.3
23.5	13.0
23.5	18.0
30.5	15.0
31.0	20.4

To examine the effect of temperature on interindividual distance in pond beetle aggregations (*D. hornii*), a series of photographs was taken of beetle aggregations located in small ponds in southwestern Ohio. These photographs were taken over water temperatures ranging from 11° to 28°C. The photographs were made into slides, projected on a screen to actual size, and the distance between individual beetles was measured as nearest neighbor distance.

Figure 1 shows that with an increase in temperature, there is a corresponding increase in nearest neighbor distance, up to 21°C, after which the nearest neighbor distance decreases.

It seems probable that an increased temperature produces both an increased metabolic rate and an increased energetic demand in stream-dwelling *Dineutes*, and that under such conditions they contact one another more often as part of their social spacing system. The maintenance of an individual distance around a beetle in a swarm is crucial to stream-dwelling *Dineutes* because each feeds at its location in the swarm, and competes for space within a circumscribed area (Kolmes, 1983b). The interindividual distances between the *D. discolor* on the river were not free to vary appreciably, as whatever number of beetles made up the swarm was limited to the small surface area of weak current behind the fallen log. This is typical of the eddy habitat of stream-dwelling gyrids (on rapidly flowing streams), and, as was true in this case, other suitable patches of habitat are often several kilometers or more distant.

The pond-dwelling *Dineutes*, in contrast, "rest" in tight aggregations but feed in a more dispersed fashion over a larger surface area that is not limited by the energetic advantages provided by a small protected area of weak current. There is therefore no advantage to these animals in defending a small individual area more intensively (by more contacts) as temperature increases, as they can merely spread further apart if greater distances between swarm members become adaptive.

Animals that aggregate must balance the benefits of aggregation against a tendency to increase individual space. As the water temperature increases, pond beetles do not increase their contact rates, but do increase their individual distance up to a point. A possible explanation of this spacing behavior relates to the primary function of these aggregations.

Gyrinid diurnal aggregations function in defense by allowing individual beetles to



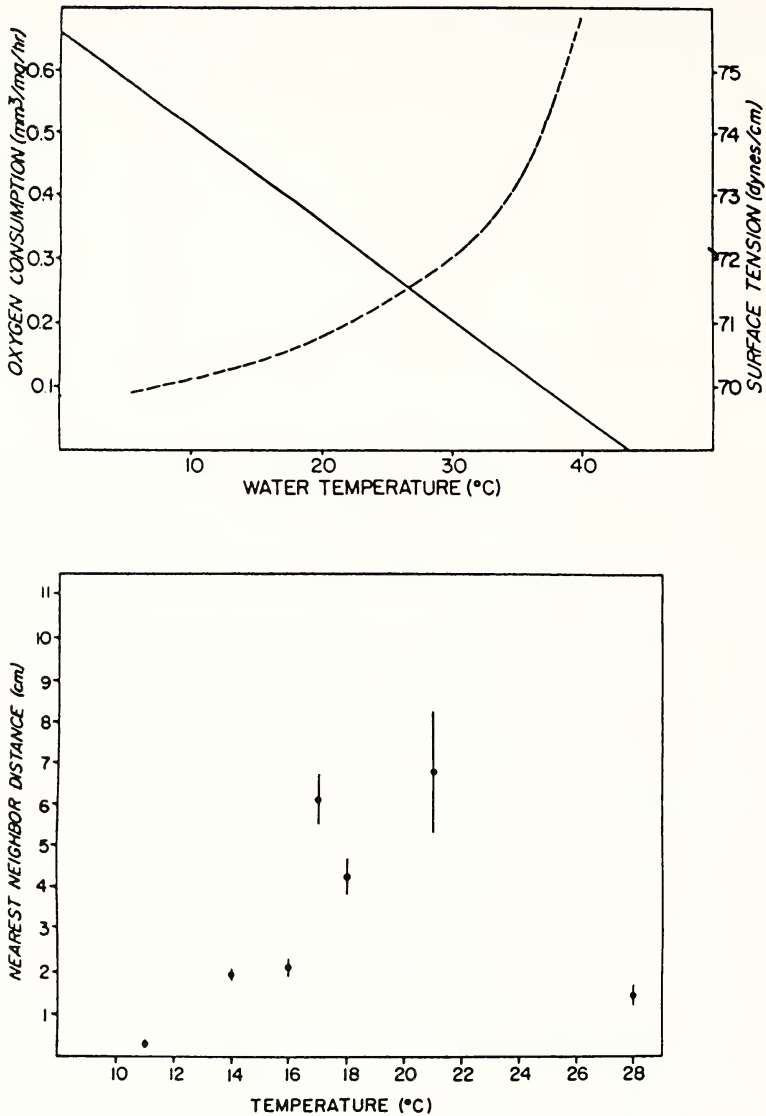


Fig. 1. LEFT. The nearest neighbor distance (cm) of gyrinids at different water temperatures (°C). Error bars are  $\pm 1$  standard error. N for each temperature: 11°C = 1,393; 14°C = 83; 16°C = 135; 17°C = 75; 18°C = 97; 21°C = 6; 28°C = 163. RIGHT. Relationship between metabolic rate of an insect as measured by oxygen consumption and temperature (°C) (dashed line). Relationship between surface tension (dynes/cm) and water temperature (°C) (solid line). The intersection of the lines would represent the theoretical maximum of nearest neighbor distance. (After Hutchinson, 1957; Keister and Buck, 1974.)

gain an early warning of approaching predators through perception of the waves generated by the swimming movements of other beetles (Vulinec, 1983). Their ability to respond quickly is related to their metabolic rate, which in turn is a function of ambient temperatures.

As the water temperature increases, the ability of the beetles to respond increases, so they can afford to be farther away from each other. However, surface waves in warm water attenuate sooner than waves in cold water. Therefore, whirligig beetles can only move a certain distance apart before they are no longer able to feel their neighbors' waves. At even warmer temperatures, wave attenuation forces the beetles to move closer together (Fig. 1).

There is some evidence that gyrenid contact behavior may have some communicatory function (Freilich, 1986). Although beetles may be exchanging information during these encounters, this possibility does not account for the difference in contact rates between pond- and stream-dwelling gyrenids.

The response of aggregating animals to environmental variables may be complex. Aggregations tend to confer on animals certain benefits—thermoregulation (Graves and Graves, 1978; Kavanaugh, 1977; Lee, 1980), exploitation of certain food sources (Tsubaki and Shiotsu, 1982), and, as in this case, protection from predators (Aldrich and Blum, 1978; Henry, 1972; Vulinec, 1983). In all cases, the overriding selection pressure appears to be the maintenance of the aggregation. Stream beetles are more constrained because of the limited eddy habitat. Aggregations may form in these beetles purely in response to this habitat. Pond beetles, however, do not need to form conspicuous aggregations in response to their habitat, and protection from predators is the primary function of these groups. With this one constraint, more flexibility is available to pond gyrenids, and they can afford to increase their inter-individual distance as conditions permit.

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## PARITY AND SUGAR FEEDING IN *ATYLOTUS BICOLOR* (DIPTERA: TABANIDAE)

LOUIS A. MAGNARELLI

Department of Entomology, The Connecticut Agricultural Experiment Station,  
New Haven, Connecticut 06504

**Abstract.**—During 1983–1985, females of *Atylotus bicolor* were collected in dry-ice baited canopy traps at 4 sites in Connecticut. Parity and stage of follicle development were determined for 52 females, all of which completed at least one gonotrophic cycle and had terminal ovarian follicles in early stages of development. Nearly half of the females contained detectable amounts of fructose. It is suspected that females produce eggs without blood meals during the first ovarian cycle and metabolize sugars for survival and dispersal.

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Immatures and adults of *Atylotus bicolor* (Wiedemann) have been collected at numerous sites in northern United States and southern Canada (Teskey, 1969, 1983). Larvae can develop in a variety of habitats including sphagnum bogs, the margins of ponds in pastures, wooded and open swamps, and in vegetation-free soils at the edges of streams and rivers. The females rarely bite humans, but they have been observed near cattle and readily enter dry ice baited canopy traps (Pechuman, 1981). Although it appears that these insects seek vertebrate blood, little is known about their feeding habits and reproductive biology. This horsefly co-exists with other tabanid species that have been found carrying the etiologic agent for Lyme disease, *Borrelia burgdorferi*, (Magnarelli et al., 1986). This study was conducted to assess vector potential in *A. bicolor* by determining stage of follicle development and parity and to determine if females ingest plant sugars for sustenance.

### METHODS

During June through August of 1983–1985, canopy traps (Pechuman, 1981) were erected at least once a week in pastures or salt marshes in the following Connecticut communities: East Haddam, Newtown, Norwich, or Milford. The first 3 are inland sites, while the last is a coastal town. In each setting, the canopy traps were placed in open areas and were baited with 2–3 kg of dry ice. Tabanids were removed from the trap heads at hourly intervals from 1000 to 1500 hours, transported on crushed ice to the laboratory, and were either dissected promptly or frozen at  $-60^{\circ}\text{C}$ . Ovaries were removed in Ringer's saline solution, and ovarioles were teased apart to determine gonotrophic age and stage of follicle development. Dissection procedures and terminology of ovarian structures follow Detinova (1962), and parity was determined by using Polovodova's method (in Detinova, 1962). Distended follicular tubes, herein designated as sac-stage, indicate recent oviposition (i.e., usually within 48 hours), whereas contracted tissues containing well-defined follicular relics were examined to determine the number of completed ovarian cycles. Follicle development was graded by using Mer's (1936) modification of Christophers' (1911) classification.

To test for fructose or fructose-yielding sugars, such as sucrose, the remaining



insect body parts were crushed as described earlier (Magnarelli and Anderson, 1981) and combined with 0.75 ml of cold anthrone reagent. This test was modified from that of Van Handel (1972) to analyze the larger-sized insects. Results were recorded within 1 hour. Although fructose and sucrose are common nectar sugars (Percival, 1961), they are also present in fruit juices (Van Handel et al., 1972) and aphid honeydew (Auclair, 1963).

#### RESULTS

The earliest record of capture of *A. bicolor* was 9 July, while the latest was 24 August (Table 1). The maximum number of females captured during any 7 hours of trapping effort was 9. All specimens were obtained between 1200 and 1500 hours on warm, sunny days.

Ovarian examinations revealed that all 52 females had oviposited at least once and were, therefore, considered parous. Of these, 43 (82.7%) had sac-staged follicular tubes with terminal follicles in very early stages of development (i.e., little or no yolk deposited) or in stage II. All 9 females with contracted follicular tubes contained one relic per ovariole and had secondary follicles in stage II. None of the females had vertebrate blood in the midgut. Fructose was detected in 24 females from all study sites. This sugar was present in specimens that had sac-like follicular tubes or contracted, follicular relics. In addition, there was no correlation between stage of follicle development and sugar-positivity.

#### DISCUSSION

Results obtained in Connecticut parallel those published earlier on geographically different populations (MacCreary, 1940; Pechuman and Burton, 1969; and Smith et al., 1970) and show that females are not routinely collected in carbon dioxide baited traps. Since all of the females examined in the present study were parous, there were no instances of females attacking cattle or humans, and since there was no vertebrate blood in digestive tracts, these insects probably produce eggs autogenously (i.e., without blood meals) during the first ovarian cycle. At the start of the second cycle, the females, like those of many other tabanid species (Thomas, 1972; Magnarelli, 1976), probably require vertebrate blood to develop eggs (anautogeny), and because they are attracted to carbon dioxide, they may enter dry ice baited traps. Although vector potential for *A. bicolor* is low, autogeny should be confirmed by allowing the females to produce eggs from stored nutrients carried over from the larval stage. Autogeny has been reported for other tabanids (Anderson, 1971; Lake and Burger, 1980; Lane et al., 1983; Thomas, 1972) and may be more prevalent than previously thought.

Relatively few adults were obtained in canopy traps, but this does not necessarily mean that *A. bicolor* is a rare species. According to Pechuman (1981), when traps are placed near the breeding sites, such as freshwater marshes, females can be readily collected. In addition to trap location, the low numbers of females captured in other habitats might be due, in part, to heavy mortality associated with the completion of the first ovarian cycle. Males do not enter canopy traps.

Similar to other tabanids, such as species of *Chrysops*, *Hybomitra*, and *Tabanus* (Magnarelli and Anderson, 1981), females of *A. bicolor* acquire fructose or sucrose

Table 1. Parity, follicular development, and presence of fructose in females of *A. bicolor* captured in canopy traps during 1983–1985.

Sites	Dates of collection	Total females	No. of parous specimens						No. with fructose
			Sac stage			Follicular relics			
			I*	I-II	II	I	I-II	II	
Milford	15 July 1983	9	0	6	2	0	0	1	5
	19 July 1983	1	0	1	0	0	0	0	1
East Haddam	23 July 1983	3	0	3	0	0	0	0	2
	24 Aug. 1983	9	0	4	2	0	0	3	2
Newtown	2 Aug. 1983	8	0	4	3	0	0	1	4
East Haddam	17 July 1984	3	0	1	2	0	0	0	2
	24 July 1984	2	0	0	0	0	0	2	1
Norwich	9, 10 July 1985	4	2	0	0	0	0	2	3
	29 July 1985	1	1	0	0	0	0	0	0
	11 Aug. 1985	1	1	0	0	0	0	0	0
East Haddam	16 July 1985	1	1	0	0	0	0	0	0
	18 July 1985	1	1	0	0	0	0	0	0
	22 July 1985	3	1	2	0	0	0	0	2
	30 July 1985	<u>6</u>	<u>5</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>
Totals		52	12	22	9	0	0	9	24

\* Roman numerals refer to stages of terminal follicle development.

and probably utilize these carbohydrates to meet the high energy demands of flight. The specific food sources and frequency of sugar feeding for *A. bicolor* adults are unknown, but if amounts of stored energy reserves are low when females start the second ovarian cycle, these sugars along with glycogen and triglyceride reserves will enhance survival and provide energy for dispersal. Therefore, the females collected in a salt marsh habitat in Milford may have originated in inland sites, which were adjacent to the marshes, and may have dispersed to the study area.

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# THE EFFECT OF DENSITY OF *AMBROSIA TRIFIDA* L. ON SEED PREDATION *EUARESTA FESTIVA* (LOEW) (DIPTERA: TEPHRITIDAE)

DAVID B. VITOLO AND EDMUND W. STILES

Ciba-Geigy Corporation, Northeast Research Station,  
R.D. 2, Box 92, Hudson, New York 12534, and  
Department of Biological Sciences and Bureau of Biological Research,  
Rutgers—The State University of New Jersey,  
Piscataway, New Jersey 08854

**Abstract**—The effect of three densities (1, 5, 10 plants/2 m<sup>2</sup>) of *Ambrosia trifida* L., a serious weed of row crops in North America and Eurasia, on seed oviposition by *Euaresta festiva* (Loew) was measured at three heights above the soil surface. The total number of seeds produced by each plant increased as height above the soil surface increased at densities of 1 and 5 plants/2 m<sup>2</sup>. The total number of seeds produced was greatest at 1 plant/2 m<sup>2</sup>. The number of seeds containing larvae expressed as either a percentage of total seeds or percentage of viable seeds was greatest at the 5 plant/2 m<sup>2</sup> density. The implications of these results regarding the establishment of biological weed control strategies for *A. trifida* are discussed.

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Giant ragweed (*Ambrosia trifida* L.) is a native, North American weed. Along with common ragweed (*Ambrosia artemisiifolia* L.) it is a serious problem in row crops and contributes to late-season, airborne pollen (Dickenson and Sweet, 1971). Samter and Durham (1955) estimated that 90% of late summer pollen in the eastern United States is produced by giant and common ragweed, which is the most important cause of allergic rhinitis and pollen asthma in North America (Patterson, 1980). Giant ragweed has become established accidentally in Eurasia, and has become a serious agricultural pest in orchards, pastures and cultivated areas of the Ukraine, Kuban, North Caucasus, and Soviet Far East (Goeden et al., 1974).

*Euaresta festiva* (Loew) is a small univoltine fly (Diptera: Tephritidae) found in the eastern and midwestern United States (Batra, 1979) which oviposits only on seeds of *A. trifida*. The larvae (1 per seed) destroy the seed and overwinter in them. Foote (1965) found that they destroy between 2–25% of seeds of *A. trifida* in Ohio. This insect has been studied as a possible candidate for biological control of *A. trifida* in Eurasia (Goeden et al., 1974), but no studies have evaluated the effect that density of host plant has on seed predation by *E. festiva*.

The objectives of this study were to determine the effect of host plant density on seed predation by *E. festiva* in an agronomic environment, and to contribute to the information on the effectiveness of this predator as a biological control agent.

## MATERIALS AND METHODS

The study was conducted within a 50 ha soybean (*Glycine max* L.) field 3.1 km west of Columbus, New Jersey (Burlington Co.), containing a natural stand of *A. trifida*. Three densities of *A. trifida* were studied: one plant/2 m<sup>2</sup>, 5 plants/2 m<sup>2</sup>, and



Table 1. The effect of plant density and height above soil surface on predation of *A. trifida* by *E. festiva*, Columbus, New Jersey, 1985.

Density	Height <sup>1</sup>	Total no. seeds	Seeds containing <i>E. festiva</i>		Viable seeds		Inviabile seeds	
			No.	% of total	No.	% of total	No.	% of total
1/2 m <sup>2</sup>	1	334bcd	5bc	1.6c	233abc	69.6	88bc	26.4
	2	677ab	20ab	3.0bc	422a	62.7	234ab	34.3
	3	806a	14bc	2.2bc	476a	60.9	315a	36.7
5/2 m <sup>2</sup>	1	65d	5c	8.1ab	38c	58.7	21c	33.2
	2	141d	11bc	9.9a	86c	60.9	44bc	29.8
	3	568abc	33a	6.8abc	371ab	64.7	164abc	28.6
10/2 m <sup>2</sup>	1	84d	3c	2.8bc	59c	72.8	26bc	30.7
	2	83d	4bc	6.6abc	52c	69.7	42bc	51.1
	3	244cd	2c	1.3c	135bc	56.9	105abc	41.8
NS <sup>3</sup>							NS	

<sup>1</sup> Height: 1 = 0.0–0.67, 2 = 0.67–1.34, 3 = 1.34–2.0 meters above soil surface.

<sup>2</sup> Duncan's Multiple Range Test. Means within a column followed by the same letter are not significantly different ( $P = 0.05$ ).

<sup>3</sup> NS = not significant.

10 plants/2 m<sup>2</sup>. Three patches of *A. trifida* were located for each density studied, and each patch was at least 20 m from its neighbor. One plant,  $2.0 \pm 0.1$  m in height, was chosen from each patch, and all seeds harvested from it on 29 September 1985. Seeds from each plant were separated into 3 groups: 0.0–0.67 m, 0.67–1.34 m and 1.34–2.0 m above the soil surface. All seeds were categorized as viable, predated (indicated by the presence of *E. festiva* larvae), or inviable (indicated by the lack of endosperm or embryo).

The data were subjected to an analysis of variance procedure utilizing the GLM procedure of the Statistical Analysis System (SAS Institute, Inc., Bo 8000, Cory, N.C.). Where significant F statistics were observed, comparisons between means were made using Duncan's Multiple Range Test as a means separation procedure.

## RESULTS

Total number of seeds produced by *A. trifida* increased with height aboveground at densities of 1 and 5 plants/2 m<sup>2</sup>, but not at 10 plants/2 m<sup>2</sup> (Table 1). The total number of seeds produced was greater at 1 plant/2 m<sup>2</sup> than either 5 or 10 plants/2 m<sup>2</sup> when averaged across all heights (Table 2). When averaged across all densities, the number of seeds found at the  $\geq 1.34$  m height was significantly greater than the  $\leq 0.67$  m height (Table 3).

There was a significant difference in the number of seeds containing *E. festiva* larvae when compared either by location on the plant or by plant density. There were more seeds on plants from less dense stands (Table 1), and there were more larvae in seeds from plants growing at 1 and 5 plants/2 m<sup>2</sup> than from plants growing at 10 plants/2 m<sup>2</sup>. Samples taken from  $\leq 0.67$  m contained significantly fewer larvae than the upper two height samples (Table 3). However, there was no difference in number of seeds containing larvae when expressed as a percentage of total seeds

Table 2. The effect of plant density on predation by *E. festiva*, Columbus, New Jersey, 1985.

Density per 2 m <sup>2</sup>	Total no. seeds	Seeds containing <i>E. festiva</i>		Viable seeds		<i>E. festiva</i> predation % of viable seeds
		No.	%	No.	%	
1	606a <sup>1</sup>	13.2ab	2.3b	377a	64a	3.75b
5	258b	16.4a	8.3a	165b	61a	13.4a
> 10	137b	2.9b	3.6b	82b	66a	4.8b

<sup>1</sup> Duncan's Multiple Range Test. Means followed by the same letter are not significantly different ( $P = 0.05$ ).

compared among heights. When the number of seeds containing larvae is expressed as a percentage of total seeds, samples taken of the 5 plant/2 m<sup>2</sup> density contained a significantly greater percentage of larvae than the higher or lower densities (Table 1).

This difference is even more pronounced when number of larvae is expressed as a percentage of viable plus predated seeds. Numbers of viable and inviable seeds, when expressed as a percentage of total seeds produced per plant, were not different from each other either for height above the ground or for plant density (Table 1). The number of larvae expressed as a percentage of viable seed was significantly greater at the 5 plant/2 m<sup>2</sup> density than at either the higher or lower density.

#### DISCUSSION

Effects of host plant density on herbivore populations have been of growing interest to ecologists studying herbivore plant interactions. There is some evidence that herbivore densities are associated with differences in plant spatial patterns, but studies have reported contradictory results. Host plants growing at low densities generally have greater herbivore abundances (Bach, 1984). However, Ralph (1977) reported greater herbivore densities in high density host patches, and Rausher and Feeny (1980) reported no density effect at all. Bach (1984) stated that we are far from able to make generalizations and predictions about density effects.

The fact that a greater number of *E. festiva* larvae were found at plant densities of 5 plants/2 m<sup>2</sup> suggests that there is an optimum density of *A. trifida* for maximum oviposition by this fly. This optimum density was not related directly to the number of potential oviposition sites as there were more seeds per plant at densities of 1 plant/2 m<sup>2</sup> and more seeds per 2 m<sup>2</sup> at densities of 10 plants/2 m<sup>2</sup>, but this result

Table 3. The effect of seed height aboveground on predation by *E. festiva*, Columbus, New Jersey, 1985.

Height aboveground (m)	Total no. seeds	Number of seeds containing <i>E. festiva</i>
1.34–2.00	539a <sup>1</sup>	16.4a <sup>1</sup>
0.67–1.34	300ab	11.8ab
0.0–0.67	161b	4.2b

<sup>1</sup> Duncan's Multiple Range Test. Means followed by the same letter are not significantly different ( $P = 0.05$ ).

may be influenced by some other unknown herbivore preference. Potential candidates include light intensity (Bach, 1984; Risch, 1981), changes in growth form due to intraspecific competition (Bach, 1981), or variations in host plant quality (Mattson, 1980). The small reduction in oviposition below 0.67 m may be due to soybean interference. Soybeans may either interfere physically with *E. festiva*, or the reduced vigor of lower parts of the host plant due to competition with the soybeans for light may render these parts of the ragweed less attractive.

Only two plant species, giant ragweed and soybeans, were found at the study site. The effect that other plant species may have, either more or different agronomic weeds or a crop of greater stature than soybeans, on oviposition by *E. festiva* on giant ragweed is unknown.

The maximum percentage predation in this study was 13.4% of all viable seeds, similar to that found by Foote (1965). This amount of predation is potentially an important selective agent on giant ragweed, but is probably not enough to act as a biological control of the total number of seeds returning to the seed bank. It is unclear how predation rates on giant ragweed seeds by *E. festiva* may differ in locations where natural enemies of *E. festiva* are not established, but studies with this insect under predator and pathogen-free conditions may help resolve this issue.

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**ON THE RELATIVE ACCEPTABILITY OF THE TYPICAL AND  
MELANIC MORPHS OF *PANTHEA PALLESCENS* MCDUNNOUGH  
(LEPIDOPTERA: NOCTUIDAE) TO BIRDS**

THEODORE D. SARGENT

Department of Zoology, University of Massachusetts,  
Amherst, Massachusetts 01003-0027

*Abstract.*—Typical and melanic individuals of *Panthea pallescens* McDunnough were presented to birds in feeding trials conducted in Leverett, Massachusetts from 1982 to 1985. Both morphs were highly acceptable to the birds, and there were no significant differences between the typicals and melanics with respect to the percentage of specimens taken, the order in which they were taken, the bird species involved, or the behaviors of the birds towards the moths. The data rule out any major difference in the acceptability of the two morphs, but the possibility that melanics might be slightly less acceptable than typicals requires further test.

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Despite an immense literature on "industrial melanism" in moths (see e.g., Kettlewell, 1973; Lees, 1981; Sargent, 1985; Lambert et al., 1986), there have been no reports to my knowledge of the relative acceptability of the typical and melanic morphs of any species exhibiting this phenomenon to avian predators. However, during the course of a long-term study on the relative acceptabilities of over 200 lepidopteran species to birds coming to a feeding tray in Leverett, Massachusetts (Sargent, in prep.), I was able to make such an assessment in the case of *Panthea pallescens* McDunnough.

It seems important to address this question at the present time, as the "classical" explanation of melanism in moths (Kettlewell, 1955, 1956, 1973) has come under increasingly critical scrutiny in recent years (Bishop, 1972; Creed et al., 1973; Sargent, 1974; Bishop and Cook, 1975; Lees and Creed, 1975; Steward, 1977a, b; Lees, 1981; Hailman, 1982; Sermoniti and Catastini, 1984; Lambert et al., 1986). The original contention that melanics enjoy a cryptic advantage on the darkened tree trunks that air pollution has created in industrial areas has been questioned on the basis of several factors, including (1) new data on the resting habits of certain moth species (Sargent, 1969, 1985; Mikkola, 1979), (2) instances of rural melanism, particularly in North America (Klots, 1964, 1966, 1968a, b; Sargent, 1971, 1974, 1983; West, 1977; Manley, 1981), (3) re-assessments of the original mark-release-recapture experiments (Kettlewell, 1955, 1956) that provide the primary evidence for the traditional interpretation (Sermoniti and Catastini, 1984), and (4) more general theoretical questions as to the adequacy of the available data to either establish the "classical" case or falsify various alternatives (Hailman, 1982; Lambert et al., 1986).

In light of this increasing skepticism regarding the role of crypsis in promoting melanism in moths, it seems appropriate to look for, and rule out where possible, any other differences between the morphs that might conceivably contribute to the "industrial melanism" phenomenon. Toward that end, I here attempt to determine whether there is an acceptability difference between the typical and melanic morphs of one species that has exhibited increased melanism in recent years.





Fig. 1. The typical (above) and melanic (below) morphs of *P. pallescens* McDunnough. Specimens from Leverett, Massachusetts, 1981. Approximately 2×life-size.

It seems possible that an acceptability difference between typical and melanic individuals might exist, based either on chemical differences between the morphs (e.g., in melanin content) that could affect their palatabilities, or on different associations that predators might make between each morph and other prey items that they encounter (e.g., typical coloration with palatability, black coloration with unpalatability). Such differences could then play a role in changing the incidence of melanism in natural populations, assuming changes in the composition of the predator and/or prey populations with which the moth species in question was associated.

#### METHODS AND MATERIALS

*Panthea pallescens* McDunnough (referred to as *P. furcilla* (Packard) in the prior papers of Ginevan, Jones, Klots, and Sargent) is bivoltine in Massachusetts with adults flying primarily in June and August. The melanic morph, "atrescens" McDunnough (1942), has increased in abundance in recent years (Klots, 1964, 1966, 1968b; Ginevan, 1971; Sargent, 1974; Jones, 1977) and presently comprises ap-



Fig. 2. The experimental feeding dish on the feeding tray at the study site in Leverett, Massachusetts. A white-breasted nuthatch is seen taking a moth.

proximately 60% of the population in the study area. The two morphs of this species are easily distinguished—the typicals having pale gray forewings with prominent black lines, and the melanics having black forewings, with the black lines at least partially edged with white (Fig. 1). I am not aware of any published reports on the resting habits of these moths, but Tobin K. Jones (pers. comm.) has found adults of both morphs resting on trunks of the normal hostplant, white pine (*Pinus strobus* L.).

The specimens were taken at 150-watt incandescent spotlights (Westinghouse outdoor projector) at my home in Leverett, Massachusetts during the collecting seasons of 1982 through 1985. (All of the moths used in this study were collected in this manner, but the butterflies were collected by net during the day, at distances of up to 10 km from my home.) All specimens were immediately frozen in small jars in the freezer compartment of a household refrigerator and were thawed just prior to their use in the bird-feeding trials.

A bird-feeding trial consisted of a 15-min presentation of six thawed Lepidoptera arranged in a circle on a 15.24 cm diameter light blue dish. In every instance, the six specimens represented six different species or distinctive morphs that had been captured within the previous 48 hr. The dish was set out on an open feeding tray (Fig. 2) which was located 1 m from a large glass door through which observations were made. The observer was approximately 2 m from the feeding tray and recorded the specimens taken, in order, and the bird species taking each insect. In addition, other behaviors of the birds were noted when they occurred, as follows: SW = specimen swallowed whole; DWE = specimen taken to perch and there de-winged and eaten; PD = specimen picked up and dropped in place; and TD = specimen taken to perch and dropped. All feeding trials were conducted between 0600 and 0800 hr EDT, and no more than four trials were run on any one day.

Two measures of acceptability for each species (or morph) tested were obtained: the overall percentage of specimens taken, and the average rank of the specimens

Table 1. The numbers and percentages of typical and melanic *P. pallescens* taken by various bird species during feeding trials in Leverett, Massachusetts, 1982–1985.

Bird species	Typical		Melanic	
	No.	Percent	No.	Percent
Blue Jay				
<i>Cyanocitta cristata</i>	52	73.2	55	73.3
Black-capped Chickadee				
<i>Parus atricapillus</i>	13	18.3	17	22.7
Tufted Titmouse				
<i>Parus bicolor</i>	3	4.2	1	1.3
White-breasted Nuthatch				
<i>Sitta carolinensis</i>	2	2.8	1	1.3
Rufous-sided Towhee				
<i>Pipilo erythrophthalmus</i>	1	1.4	1	1.3
Totals	71		75	

taken. These two measures were highly correlated (Pearson's correlation coefficient:  $r = -0.435$ ,  $P < 0.001$  for the 156 species tested on at least two occasions,  $r = -0.699$ ,  $P < 0.0001$  for the 69 species tested on more than 10 occasions), indicating that preferred species were both taken more often and taken earlier in the trials than were less preferred species.

These two measures of acceptability were then utilized to develop a ten-category classification of all of the species (or morphs) that were tested in the feeding trials—these categories ranging from most acceptable (category 1) to least acceptable (category 10) to birds. The percentage of specimens taken and the average rank of the specimens taken were scored as follows:

Percent taken	Score	Average rank	Score
80–100	1	1–1.9	1
60–79	2	2–2.9	2
40–59	3	3–3.9	3
20–39	4	4–4.9	4
0–19	5	5–6	5

Table 2. The behavioral responses of birds to typical and melanic specimens of *P. pallescens* during feeding trials in Leverett, Massachusetts, 1982–1985.

Behaviors	No. of observations (%)	
	Typical	Melanic
Flew off with moth	55 (76.4)	62 (79.5)
Swallowed moth whole	15 (20.8)	11 (14.1)
De-winged and ate moth	1 (1.4)	2 (2.6)
Did not touch	1 (1.4)	3 (3.8)
Totals	72	78

Table 3. The numbers and percentages of typical and melanistic *P. pallescens* taken by rank during feeding trials in Leverett, Massachusetts, 1982–1985.

Ranks	Typical		Melanic	
	No.	Percent	No.	Percent
1	24	33.8	15	20.0
2	20	28.2	21	28.0
3	16	22.5	20	26.7
4	5	7.0	11	14.7
5	5	7.0	6	8.0
6	1	1.4	2	2.7
Totals	71		75	

An overall score was obtained by averaging the scores obtained from the percent taken and average rank values. In this way, nine acceptability categories were created with scores ranging from 1, in 0.5 step increments, to 5. In addition, a category 10 was established for those species that were never taken by the birds.

Chi-square goodness-of-fit and contingency tests (Siegel, 1956) were used in analyzing the data.

#### RESULTS

Overall, 71 out of 72 typicals (98.6%) and 75 out of 78 melanics (96.2%) were taken by birds ( $P > 0.30$ ) (Fig. 3). The numbers of specimens taken by the different bird species visiting the feeder were virtually identical for the two morphs (Table 1), as were the observed behavioral responses of these birds to the moths (Table 2). No specimen of either morph was picked up and dropped (PD) or taken and dropped (TD) by the birds.

The average rank of the typicals taken was 2.30, and the average rank of the

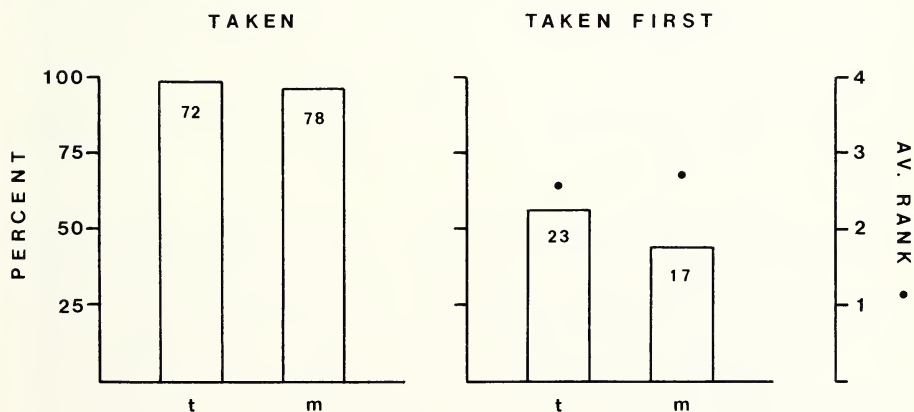


Fig. 3. The percentages of typical and melanistic *P. pallescens* taken overall (left) and taken first when paired (right), and the average ranks of typicals and melanics overall (dots). Numbers of individuals are given within the bars; t = typicals, m = melanics.



Table 4. Representative species from the 10 acceptability categories used in the present study.

Category (no. species)	Species (family)	N	% taken	Av. rank
1 (15)	<i>Ceratomia undulosa</i> (Walker) (Sphingidae)	15	100.0	1.5
	<i>Euparthenos nubilus</i> (Hübner) (Noctuidae)	10	100.0	1.6
	<i>Acrionicta americana</i> (Harris) (Noctuidae)	45	100.0	1.7
	<i>Agrotis ipsilon</i> (Hufnagel) (Noctuidae)	14	100.0	1.9
2 (35)	<i>Malacosoma americanum</i> (F.) (Lasiocampidae)	46	93.5	2.6
	<i>Peridea ferruginea</i> (Packard) (Notodontidae)	20	95.0	2.7
	<i>Pyrharctia isabella</i> (J. E. Smith) (Arctiidae)	47	93.6	2.6
	<i>Catocala amica</i> (Hübner) (Noctuidae)	30	93.3	2.8
	<i>Charadra deridens</i> (Guenée) (Noctuidae)	35	97.1	2.7
3 (41)	<i>Cercyonis pegala</i> (F.) (Satyridae)	23	73.9	2.9
	<i>Prochoerodes transversata</i> (Drury) (Geometridae)	37	89.2	3.2
	<i>Dryocampa rubicunda</i> (F.) (Saturniidae)	56	83.9	3.2
	<i>Spilosoma congrua</i> Walker (Arctiidae)	34	91.2	3.4
	<i>Lymantria dispar</i> ♂ (L.) (Lymantriidae)	51	84.3	3.1
4 (18)	<i>Epargyreus clarus</i> (Cramer) (Hesperiidae)	15	73.3	3.6
	<i>Malacosoma disstria</i> Hübner (Lasiocampidae)	13	100.0	4.2
	<i>Parallelia bistriaris</i> Hübner (Noctuidae)	42	78.6	3.4
5 (20)	<i>Papilio troilus</i> L. (Papilionidae)	18	66.7	4.4
	<i>Colias eurytheme</i> Boisduval (Pieridae)	19	73.7	4.5
	<i>Basilarchia archippus</i> (Cramer) (Nymphalidae)	29	51.7	3.5
	<i>Xanthotype sospeta</i> (Drury) (Geometridae)	17	70.6	4.6
6 (16)	<i>Papilio glaucus</i> L. (Papilionidae)	19	36.8	3.4
	<i>Artogeia rapae</i> (L.) (Pieridae)	43	46.5	4.3

Table 4. Continued.

Category (no. species)	Species (family)	N	% taken	Av. rank
	<i>Desmia funeralis</i> (Hübner) (Pyrilidae)	11	27.3	3.3
	<i>Campaea perlata</i> (Guenée) (Geometridae)	41	53.7	4.1
7 (4)	<i>Danaus plexippus</i> (L.) (Danaiidae)	17	35.3	4.2
	<i>Euchlaena irraria</i> (Barnes and McDunnough) (Geometridae)	11	54.5	5.3
8 (4)	<i>Phyciodes tharos</i> (Drury) (Nymphalidae)	11	27.3	5.7
	<i>Drepana arcuata</i> Walker (Drepanidae)	10	20.0	5.0
9 (2)	<i>Itame pustularia</i> (Guenée) (Geometridae)	6	16.7	5.0
	<i>Haploa lecontei</i> (Guérin-Meneville) (Arctiidae)	17	11.8	5.0
10 (8)	<i>Hypoprepia fucosa</i> Hübner (Arctiidae)	19	0.0	—
	<i>Cisseps fulvicollis</i> (Hübner) (Arctiidae)	8	0.0	—

melanics taken was 2.71 (Fig. 3). The distributions of ranks for the two morphs (Table 3) were not significantly different ( $P > 0.30$ ).

On the basis of percent taken and average rank, both morphs were assigned to category 2 in the ten-category classification of acceptabilities previously described. For comparison, Table 4 lists a representative array of butterflies and moths ranging from category 1 to category 10 that were also tested in the present study. Both morphs of *P. pallescens* rated slightly above the average for all noctuids tested (887 individuals of 88 species, 93.5% taken, average rank 2.73, average category 2).

Finally, on 40 occasions both morphs were presented to the birds in the same feeding trial. In these cases, the typical was taken first 23 times (57.5%) and the melanic was taken first 17 times (42.5%) ( $P > 0.30$ ) (Fig. 3).

#### DISCUSSION

The data presented here indicate that both the typical and melanic morphs of *P. pallescens* are highly acceptable to avian predators. There were no significant differences between the morphs in terms of (1) the numbers of individuals taken, (2) the ranks at which they were taken, (3) the bird species taking them, and (4) the behavioral reactions of the birds to them. In addition, there was no significant difference in the likelihood of either morph being taken first when typicals and melanics were paired in the same feeding trials. Thus, the general conclusion would be that there are no differences in acceptability between the typical and melanic morphs of this species to typical avian predators of the sort they face in nature.

There are hints, however, that the matter cannot be entirely laid to rest. For one

thing, melanics fared less well than typicals in every measure used, albeit never significantly so. Thus, fewer melanics were taken overall, they ranked lower than typicals on average, they were less often swallowed whole, and were less likely to be taken first when paired with typicals. This agreement in the direction of difference between the morphs in every measure used is itself improbable, if the morphs are indeed equally acceptable to birds. Thus, while a large difference in acceptability seems safely ruled out by the present data, one cannot rule out the possibility that melanics are slightly less acceptable than typicals.

The question that arises here is the familiar one involving the meaning of statistical significance, or insignificance, in an evolutionary context. If, for example, melanics were not eaten once in every 100 encounters with predators, but typicals were always eaten when encountered, one could not detect this difference (at  $P < 0.05$ ) until one had witnessed nearly 400 instances of each type of encounter. Yet this difference, though smaller than that found between typicals and melanics in the present study, would provide a selective advantage that could ultimately lead to the total replacement of typicals by melanics in a natural population (Fisher, 1930; Falconer, 1960; Dobzhansky, 1970). [Replacement in this case would be relatively rapid, given the simple dominance of the melanic condition (Ginevan, 1971).]

In the present study there was 2.4% difference between the morphs in terms of individuals taken. This difference was insignificant, given the present sample size; but would be significant at  $P < 0.05$ , if a sample size four times larger than the present one had been obtained. Similarly, the difference between the morphs in the distribution of ranks that was obtained (Table 3) would be significant at  $P < 0.05$ , if the sample size were doubled.

Thus, a decision as to whether the differences between typicals and melanics reported here represent (1) sampling errors that are to be expected when two sets of individuals are drawn from a single population, or (2) a small, but potentially important, difference in the acceptability of the two morphs, must await the acquisition of additional data.

#### ACKNOWLEDGMENTS

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## NECTAR AND POLLEN COLLECTION BY BUMBLE BEES: METHODOLOGY FOR A COLONY-LEVEL APPROACH

RICHARD M. FISHER<sup>1</sup>

Department of Zoology, University of Toronto, M5S 1A1, Canada

*Abstract.*—Recent studies of bumble bee foraging (*Bombus* spp.; Hymenoptera: Apidae) stress the importance of examining this behaviour from a colony standpoint. The possible advantages of this approach are demonstrated, employing a methodology which allows repeated measurements of individual pollen and nectar loads brought back to the nest, without disturbing the bees.

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In recent years, a large body of literature has emerged on the study of foraging behaviour in bumble bees (see reviews by Morse, 1982, and Pyke, 1985). Despite this extensive data base, very little is known about the collection of pollen, and about the interaction between pollen and nectar collection. Lack of information on these subjects is due to a large extent to the inability to remove pollen and nectar loads without killing or disturbing foraging workers. Another potential drawback is the reliance of most students of bumble bee foraging behaviour solely upon observations of workers in the field. An alternative emphasis, stressing the needs of a given colony and how foraging by workers satisfies those needs, has been forwarded by Heinrich (1983) and Teras (1985). According to this view, knowledge about how individual decisions are made by workers is not important so long as the success achieved by those decisions (i.e., the amount of pollen and nectar collected) can be measured. In this study, an attempt was made to circumvent these two problems by designing an experimental bumble bee hive which would allow pollen and nectar weights to be calculated without disturbing or sacrificing members of a colony. The hive's usefulness was tested by measuring the collection of pollen and nectar by various-sized workers of *Bombus griseocollis* De Geer.

### MATERIALS AND METHODS

One colony of *B. griseocollis* was reared in the laboratory, using the methods of Pomeroy and Plowright (1980). The comb from this colony was moved to another hive, modified in the following way: all existing pollen receptacles (either empty cocoons or wax cylinders constructed by workers especially for the storage of pollen) were removed, and replaced by three false pollen pots. These false pots consisted of plastic tubes (OD 12 mm) placed among groups of cocoons, and extending down through the hive base. Inside each tube a plunger was fitted (a capsule normally used for plastic embedding in electron microscopy) which could be removed from below the hive via a wire handle (see Fig. 1). Previous testing in a flight cage showed that

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<sup>1</sup> Present address: Department of Botany and Zoology, Massey University, Palmerston North, New Zealand.

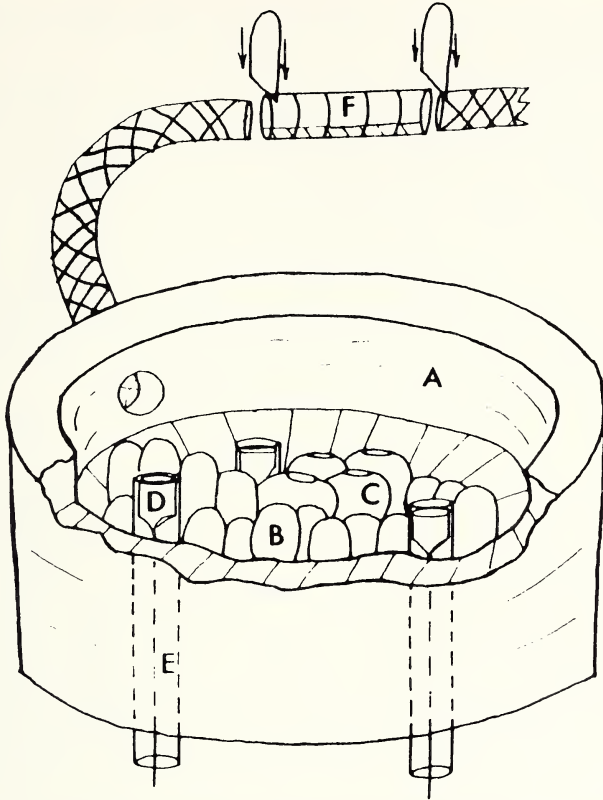


Fig. 1. Experimental hive. Legend: A) hive body, B) brood comb, C) nectar pot, D) plunger of false pollen pot, E) plastic tube, F) weigh cage.

incoming foragers laden with pollen found these false pots suitable substitutes for their normal pollen receptacles (particularly if the pot had previously been primed with a small amount of pollen), and rubbed pollen from their legs into them. The pollen could be removed, weighed, and returned without disturbing the nest. Note: the diameter of the false pots and the use of a hive like that which is illustrated are not critical in pollen measurement, and are provided only as guidelines. There is no reason, for example, why the methodology could not be extended to other groups such as stingless bees (*Meliponidae*).

The weight of nectar which was brought back to the nest also was measured, by isolating and weighing foragers in a cage as they left the nest, and again when they returned. The weigh cage was constructed from a clear plastic tube (12 mm OD  $\times$  50 mm length) with wire mesh floor. The tube was connected at both ends to a flight tunnel. Pieces of plastic card were pushed through slots cut into each end of the cage in order to trap ingoing and outgoing foragers. The entire cage was then removed and weighed. The resulting datum from each returning forager, following subtraction of the outgoing bee weight (and weight of the empty cage), provided the weight of

nectar (+ pollen in some cases). The empty weight of each forager was determined later by food-depriving bees for 12 hr and reweighing them.

The modified hive was connected by a wire mesh tube to the window of a house in Peterborough, Ontario, for a 17 day period beginning 17 July. All of the bees were individually marked. After a five-day adjustment period, 25 *B. griseocollis* workers were monitored while they foraged for nectar. A further 21 workers were monitored while they foraged for pollen. These numbers represent the entire complement of bees which foraged during the experimental period. Observations were conducted at the same time each day, with two periods of observation per day (900 to 1100, and 1300 to 1600 hr EDT). An attempt was made to measure bees of dissimilar weights, and those collecting nectar and pollen, during each observation period (range = 2 to 7 monitored trips per bee). At the end of the experiment, 15 *B. griseocollis* workers were food-deprived for 12 hr and then weighed. The resulting weights, and the length of the wing radial cell for each of the 15 workers were recorded.

#### RESULTS AND DISCUSSION

A high degree of correlation was found between wing radial cell length and body weight ( $r = 0.92$ ,  $P < 0.01$ ). Thus, further analysis in which bee size was equated with weight was considered justified.

The bees in the colony did not appear to be disturbed either by the temporary removal of pollen, or by their own brief removal from the flight tube in order to weigh outgoing and incoming foragers. In order to compare the foraging behaviour of workers, rates of nectar and pollen collection were calculated by converting the amount with which bees returned to an hourly rate, and averaging this figure for the number of trips made by each bee. Heavier *B. griseocollis* workers were better nectar foragers, irrespective of whether or not they also collected pollen (Fig. 2a:  $P < 0.005$  for nectar-only bees,  $P < 0.005$  for pollen-collecting bees; Spearman rank correlation for both). A partial explanation for the variance in foraging rate may be the size of nectar load with which workers returned. A comparison between bee weight and the heaviest load with which bees returned (irrespective of trip duration) showed a significant positive relationship ( $r_s = 0.55$ ;  $P < 0.01$ ).

There appeared to be a size difference between nectar- and pollen-collecting bees (see data in Fig. 2a: Mann-Whitney  $U$ -test;  $P = 0.05$ ). However, there was no relationship between bee weight and the rate of pollen collection (Fig. 2b:  $r_s = 0.39$ ;  $P > 0.3$ ).

The experimental hive which has been described provides an easily manageable way of obtaining repeated measures of nectar and pollen collection from bumble bee workers within a given colony. The results which were obtained with the hive suggest that large *B. griseocollis* workers are better foragers than their smaller nestmates, measured by the weight of nectar with which they return, and by their rate of nectar collection. These findings support the view that the greater cost in rearing larger workers (see data in Pomeroy, 1979) is at least partially repaid by the better rate at which larger bees forage. This is a different result than that of Morse (1978), who found no intraspecific variation in nectar-foraging ability in workers of *B. vagans* Smith, another bumble bee species with variable worker sizes. The study by Morse, however, includes data from bees collecting nectar from a single plant species, and

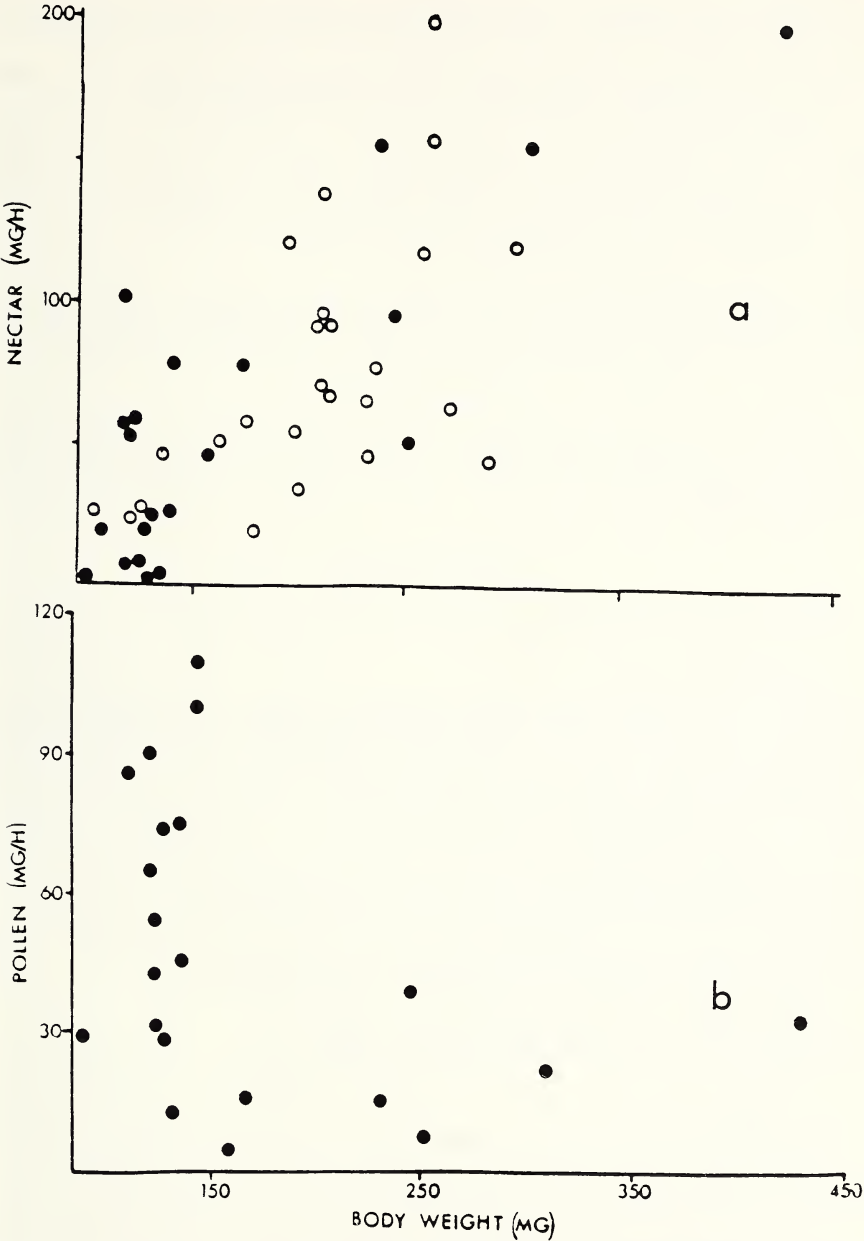


Fig. 2. a) Nectar collection rates of *B. griseocollis* workers of different weights. Clear circles denote bees which collected only nectar, solid circles denote bees which collected both pollen and nectar; b) pollen collection rates of *B. griseocollis* workers of different weights.



may illustrate the differences which can emerge when the present methodology is employed.

That most workers collected nectar while collecting pollen suggests that pollen collection is ancillary to nectar collection. Bumble bee colonies may be better able to withstand pollen rather than nectar shortages (particularly larvae: see Plowright and Jay, 1977), and there may be less selection pressure on colonies to produce workers of different sizes which are differentially proficient in pollen collection. Of course, much more data on a variety of *Bombus* species are required, comprising complete colony developmental stages, before this question can be satisfactorily resolved. Studies such as these can be expanded in scope far beyond this paper, the main purpose of which is to show that much valuable information can be quickly gathered on bumble bee foraging behaviour using the proposed methodology.

#### ACKNOWLEDGMENTS

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**TERRESTRIAL HYDROMETRIDAE (HETEROPTERA) FROM  
MADAGASCAR, AND THE REMARKABLE THORACIC  
POLYMORPHISM OF A CLOSELY RELATED  
SPECIES FROM SOUTHEAST ASIA**

JOHN T. POLHEMUS AND DAN A. POLHEMUS

University of Colorado Museum, 3115 South York Street,  
Englewood, Colorado 80110

*Abstract.*—Two new species of terrestrial *Hydrometra*, *H. phytophila* and *H. cavernicola*, are described from the rain forests of Mt. d'Ambre in northern Madagascar. The first species occurs in understory vegetation, often far from streams, and the second on damp rock walls; these are the first truly terrestrial Hydrometridae reported. These new taxa belong to a monophyletic subgroup within *Hydrometra* whose other members occur in Madagascar, Ceylon, and southeast Asia, a vicariant distribution pattern which is interpreted to have arisen via the rifting of Madagascar from India in the Cretaceous. One Asian member of this complex, *H. aberrans* Hungerford and Matsuda, is found to exhibit a remarkable polymorphism in regard to the presence or absence of a large tubercle on the thoracic dorsum. Aptery within the genus *Hydrometra* is discussed in comparison to other members of the Gerromorpha. A check list of *Hydrometra* species occurring in Madagascar is provided.

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Members of the family Hydrometridae have been traditionally considered as semiaquatic insects whose existence is closely tied to aquatic habitats. It was thus with some surprise that the junior author discovered one in his net far from any stream while sweeping for terrestrial Heteroptera in the understory vegetation of the Mt. d'Ambre forest reserve in northern Madagascar. His suggestion that this specimen might have come off plants was met with general skepticism by others in the collecting party, who proposed instead that it must have been carried in the net from a previous stream locality. A similar discovery by the same author at a different site the following day, however, led to an intensive search that proved nymphs and adults of this insect do indeed inhabit vegetation, even at considerable distances from water, a habit quite different from that previously documented for any other *Hydrometra* species.

A closely related new species was also found on the same mountain inhabiting damp rock walls in caves and dark rock-holes in waterfall splash zones. This second species apparently is restricted to hygropetric habitats, and was never found on the surfaces of adjacent streams. The presence of this closely allied species with an annectant behavior pattern and habitat preference strongly suggests that the transition from a subaquatic to terrestrial existence in *Hydrometra* has occurred locally in the rain forests of Madagascar, and that this ecological character can be useful in assessing phylogenetic relationships. In addition to the two unusual species noted above, several *Hydrometra* species with typical morphology and behavior (*H. fanjahira* Hungerford and Evans, *H. bifurcata* Hungerford and Evans) were also abundant on the streams of Mt. d'Ambre, so that at this single locality the entire spectrum of ecological roles in the genus, from semiaquatic to terrestrial, was represented.

Although the new species described herein is the first truly terrestrial hydrometrid

documented, various taxa within the family are known to spend portions of their lives on land. Temperate zone species of *Hydrometra* frequently retreat to moist streamside habitats of leaf litter and damp moss in winter to avoid the ice that forms on their aquatic habitats (Hungerford, 1920; Andersen, 1982). *Chaetometra robusta* was collected from ferns in the Marquesas Islands (Hungerford, 1939), and the type locality of *Heterocleptes hoberlandti* was listed as "detritus on soil" in the gallery forest along the Luachino River in Angola. In all of the above cases, though, these species were found very near water in riparian habitats.

The two new species from northern Madagascar are most closely allied to *H. madagascarensis* Hungerford and Evans, known from the eastern rain forests of the island. Outside Madagascar the closest relatives of these three species are *H. zeylanica* Gunawardane and Karunaratne from Ceylon, and *H. longicapitis* Bueno and *H. aberrans* Hungerford and Matsuda from southeast Asia. The distinctively narrow elongated head and relatively short thorax shared by all these taxa are not found in any known African species, despite the close geographical proximity of Madagascar to that continent. The present distribution and relationships argue instead for a vicariance pattern involving India and Madagascar, probably dating from the rifting of Gondwanaland in the Cretaceous. A similar distribution pattern is seen in Leptopodidae, ptilomerine Gerridae, and certain mayflies, and we hypothesize that India and Madagascar were separated from Africa as an intact subcontinent, with India subsequently rifting from Madagascar and drifting north across the equator to contact southern Asia. Many elements of the tropical fauna carried on India were then able to disperse into the ancient rain forests of southeast Asia via Assam and Burma. The continuing rise of the Himalaya in response to the impact of drifting India has caused desertification of the central Indian subcontinent, leaving Ceylon as an isolated tropical refugium and producing the discontinuous distributions seen today.

All measurements are given in millimeters. Specimen depository abbreviations are indicated in the acknowledgments. This research was supported in part by a grant from the National Geographic Society, Washington, D.C.

### ***Hydrometra phytophila*, new species**

Figs. 1-4, 8, 9

*Diagnosis.* *Hydrometra phytophila* is very closely related to *Hydrometra madagascarensis* Hungerford and Evans (1934). It differs from the latter in having the lateral spines on the base of abdominal sternite VII closer to the medial spines, the anteocular part of the head much shorter in relation to the postocular part (ratio AO/PO for *phytophila* = 2.01, for *madagascarensis* = 2.65), and the connexiva light except narrowly on the margins (versus broadly black).

*Description.* Extremely long and slender; only apterous and micropterous forms known. Ground color yellow brown; abdominal tergites shining, lighter. Head, thorax lightly frosted. Venter mostly yellowish; collar, coxal cavities slightly darker. Connexiva narrowly margined with black, also narrowly along abdominal tergites in female. Legs, antennae brownish yellow; antennal segments I-II distally, distal 1/10 of III-IV, all tibia distally, rostrum distally, ventral lobe of head, brownish; all femora contrasting deep brown on distal 1/20.

Structural characteristics: Head extremely long (4.29 mm), widest (0.35 mm) at

antennal tubercles; ventral lobe large (Fig. 1); rostrum reaching behind eyes; ratio anteocular/postocular portions: 2.73/1.36 mm; interocular space/width of an eye: 0.11/0.14 mm; clypeus narrow, forming an acute angle apically, tip narrowly rounded. Antennal formula I–IV: 0.40; 1.16; 4.80; 1.82 mm. Prothorax with an encircling row of pits anteriorly, demarcating collar; anterior pronotal lobe with tiny pits usually marked with white; posterior lobe with numerous small deep pits. Pronotum length 1.21 mm; remainder of thorax 1.16 mm; abdomen length 5.30 mm. Distance between anterior and middle coxae (measured between closest margins) 0.45 mm; between middle and hind coxae 1.10 mm. Anterior coxae with 2 pits on anterior part, 2 on posterior part; middle coxae with 2 pits on anterior part, 3 on posterior part; hind coxae with 2 pits.

Proportions of legs as follows, in mm:

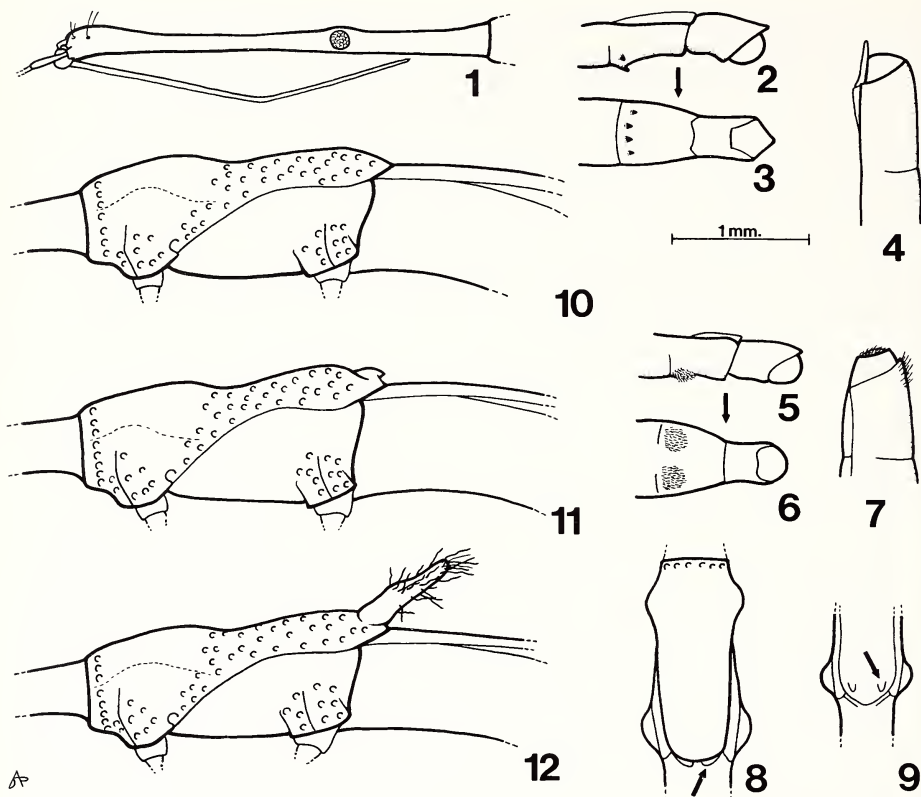
	Femur	Tibia	Tarsal 1	Tarsal 2	Tarsal 3
Anterior	3.94	5.25	0.10	0.35	0.20
Middle	4.19	5.56	0.10	0.30	0.15
Posterior	5.86	8.94	0.10	0.35	0.15

Male and female with abdominal terminalia and genital segments as shown in Figures 2–4. Length, apterous male 12.38 mm; apterous female 12.58 mm.

*Discussion.* *Hydrometra phytophila* is a member of a monophyletic subgroup within *Hydrometra* that also contains *H. cavernicola* n. sp. and *H. madagascarensis* Hungerford and Evans. The closest apparent relatives of these species are *Hydrometra zeylanica* Gunawardane and Karunaratne from Ceylon and *H. longicapitis* Bueno and *H. aberrans* Hungerford and Matsuda from southeast Asia. The latter share with all three of the above species the following characteristics: very long slender body; relatively short thorax; both head and abdomen elongated and conspicuously longer than the thorax; head with small maxillary plates and large ventral lobes; male abdominal segment VII short, shallowly excavate medially with ventral processes near anterior margin; male genital segments not modified (terminology follows Andersen, 1982). The Asian members of this group differ from the Malagasy species in the following respects: the clypeus is somewhat broader; in the female of both species and the male of the latter the abdomen is curved; the apterous forms are unknown. A review of the *Hydrometra* species of the world reveals that while a Neotropical group (including *H. caraiba* Guérin-Meneville, *H. huallagana* Drake, *H. olallai* Mychajliw and *H. metator* White) plus *H. papuana* Kirkaldy from the Malay Archipelago all share with the above species the very long head, it is not nearly as slender, and the thorax is elongated and subequal in length to both the head and abdomen.

The three Madagascar species discussed here are all apterous except for one micropterous female (Fig. 8), seemingly an apomorphy for this group. The significance or even the definition of aptery in *Hydrometra* is, however, unclear. The phenomenon seems to be quite rare in the genus, and further it is not certain that true aptery even occurs. Torre-Bueno (1926) stated that of the many *Hydrometra martini* Kirkaldy that he studied a few were apterous, however we are unable to confirm the existence of this morph in *martini*; we have examined many specimens, and those that appeared apterous in dorsal view have tiny wing pads hidden under the posterior margin of the pronotum, visible without dissection. Almost all species of *Hydrometra* are rep-





Figs. 1-4, 8, 9. *Hydrometra phytophila*. 1. Head. 2. Male abdomen, lateral view. 3. Male abdomen, ventral view. 4. Female abdomen, lateral view. 8. Thorax, micropterous form, dorsal view, showing small wing pads (arrow). 9. Thorax, apterous form, dorsal view with pronotal lobe removed, showing wing rudiments (arrow).

Figs. 5-7. *Hydrometra cavernicola*. 5. Male abdomen, lateral view. 6. Male abdomen, ventral view. 7. Female abdomen, lateral view.

Figs. 10-12. *Hydrometra aberrans*, thorax, lateral view, showing three pronotal morphs. 10. Normal form. 11. Pronotal lobe with incipient tubercle. 12. Pronotal lobe with tubercle, the *aberrans* form.

resented in the Polhemus collection and a quick survey revealed only two species that are predominately wingless and seem to be potentially apterous, aside from the three Madagascar taxa discussed above: *Hydrometra hungerfordi* Bueno and *Hydrometra aculeata* Montrousier. When the pronotum of each of these species is removed, small strap-like wings are revealed that do not reach the posterior pronotal margin; these are not visible without dissection. The reduction in *H. phytophila* n. sp. and *H. cavernicola* n. sp. is even more profound, as the wings are represented by tiny fleshy buds far removed from the posterior margin of the pronotum (Fig. 9), visible only after removal of the pronotal lobe. This apparently does not represent true aptery in the same sense as in Gerromorphan genera where the thoracic sclerites of the truly apterous morph are dramatically different from those of the winged morph

and there are clearly no wing rudiments, e.g., *Mesovelia*, *Limnogonus*, *Eurygerris*, *Gerris* (the two different forms of aptery in *Gerris* were illustrated and discussed by Andersen, 1982, pp. 296–301). We predict that if and when a *Hydrometra* species is found without wing rudiments it will have a much altered thoracic morphology.

The very long narrow head coupled with a shortened thorax and predominant flightlessness are considered to be derived states, the latter perhaps a consequence of the return to a terrestrial habitat.

*Habitat data.* The forest at the Mt. d'Ambre type locality is a primary moist montane forest which was selectively logged for valuable hardwoods during the French colonial period but has subsequently been left undisturbed and allowed to regain its original stature. Dominant tree species are members of the Sapindaceae, Sapotaceae and Myrtaceae which form a closed canopy approximately 25 m above the ground. The type series of *Hydrometra phytophila*, n. sp. was taken by sweeping the understory vegetation below this canopy. The insects were especially abundant on ferns and soft stemmed vegetation, however JTP found several specimens on earth beneath the vegetation on a trailside bank. Individuals were frequently taken at great distances (up to several km) from any discernable water source, and in collecting along transects perpendicular to the stream near Petite Cascade they were not found closer than 1 meter to the stream, indicating that they are truly terrestrial in habit and not closely tied to riparian communities.

*Etymology.* The name *phytophila* refers to the preferred microhabitat of this species, on shaded forest vegetation.

*Holotype apterous male and allotype apterous female.* MADAGASCAR, Diego Suarez Province, Petite Cascade trail, Montagne d'Ambre Forest Reserve, south of Diego Suarez, 990 m (3,250 ft), 16 November 1986, CL 2280, J. T. & D. A. Polhemus (USNM).

*Paratypes.* MADAGASCAR. Diego Suarez Province. Many apterous males and females, 1 micropterous female, same data as holotype (JTPC; TSIM); 1 apterous male, 1 apterous female, Grande Cascade, ragged rock face beside waterfall, Montagne d'Ambre forest reserve, 670 m (2,200 ft), 14 November 1986, CL 2278, J. T. & D. A. Polhemus (JTPC).

### ***Hydrometra cavernicola*, new species**

Figs. 5–7

*Diagnosis.* *Hydrometra cavernicola* is most closely related to *H. madagascarensis* Hungerford and Evans and *H. phytophila*; see discussion under the latter above. *H. cavernicola* may be separated from *H. madagascarensis* by the much shorter anteocular portion of the head (ratio AO/PO for *cavernicola* = 2.08, for *madagascarensis* = 2.65), and from *H. phytophila* by the medially dark abdominal tergites which are weakly carinate on their midline, versus non-carinate light tergites in *phytophila*, and by the brush-like processes on sternite VII versus dark acuminate structures in the latter species.

*Description.* Long and slender; only apterous form known. Ground color light brown; abdominal tergites not shining, lighter laterally, tergites II–VI carinate and brown medially. Venter mostly yellowish; collar, coxal cavities slightly darker. Connexiva narrowly margined with blackish brown shading to yellowish medially, brown along abdominal tergites except broadly yellowish behind segmental sutures. Legs, antennae brown; all femora contrasting deep brown on distal  $\frac{1}{20}$ .

Structural characteristics: Head very long (4.14 mm), widest (0.40 mm) at antennal tubercles; ventral lobe large; rostrum reaching behind eyes; ratio anteocular/post-ocular portions: 2.68/1.32 mm; interocular space/width of an eye: 0.11/0.18 mm; clypeus narrow, tapering anteriorly, tip broadly rounded. Antennal formula I–IV: 0.51; 1.16; 5.15; 2.07 mm. Prothorax with an encircling row of pits anteriorly, demarcating collar; anterior pronotal lobe and to a lesser degree posterior lobe with tiny pits usually marked with white; posterior lobe with numerous small deep pits. Pronotum length 1.33 mm; remainder of thorax 1.44 mm; abdomen length 5.15 mm. Distance between anterior and middle coxae (measured between closest margins) 0.54 mm; between middle and hind coxae 1.30 mm. Anterior coxae with 2 pits on anterior part, 2 on posterior part; middle coxae with 2 pits on anterior part, 3 on posterior part; hind coxae with 3 pits.

Proportions of legs as follows, in mm:

	Femur	Tibia	Tarsal 1	Tarsal 2	Tarsal 3
Anterior	4.46	4.85	0.07	0.25	0.25
Middle	4.86	5.30	0.07	0.22	0.10
Posterior	6.19	8.43	0.07	0.18	0.25

Male and female with abdominal terminalia and genital segments as shown in Figures 5–7. Length, apterous male 12.00 mm; apterous female 12.80 mm.

*Discussion.* The relationship of this species to other *Hydrometra* species is discussed above under *H. phytophila*.

*Habitat data.* The type series of *H. cavernicola* was taken from the damp rock walls of a basalt cave adjacent to the Petite Cascade at Mt. d'Ambre, in company with emesine Reduviidae. The insects were slow or inactive until disturbed, but would then move quickly across the vertical rock surface in attempts to escape. At the Grand Cascade locality specimens were taken from dark pockets protected by overhanging rock on the rugged basalt wall next to the waterfall.

*Etymology.* The name *cavernicola* refers to the preferred microhabitat of this species, in moist, shaded caverns and rock holes.

*Holotype apterous male and allotype apterous female.* MADAGASCAR, Diego Suarez Province, Petite Cascade, cave alongside plunge pool, Montagne d'Ambre Forest Reserve, south of Diego Suarez, 990 m (3,250 ft), 16 November 1986, CL 2280, J. T. & D. A. Polhemus (USNM).

*Paratypes.* MADAGASCAR. Diego Suarez Province. Many apterous specimens, males and females, same data as holotype (JTPC, TSIM); 2 apterous males, 1 apterous female, Grande Cascade, ragged rock face beside waterfall, Montagne d'Ambre forest reserve, 670 m (2,200 ft), 14 November 1986, CL 2278, J. T. & D. A. Polhemus (JTPC).

#### *Hydrometra madagascarensis* Hungerford and Evans

*Hydrometra madagascarensis* Hungerford, H. B. and N. E. Evans, 1934. Ann. Mus. Nat. Hung. 28:87 (Described from 1 male and 1 female, Foret Tanala, Reg. de Ranomafana).

*Discussion.* We have examined specimens from a long series of this species housed in the Zoological Institute of Leningrad. Although we collected in aquatic habitats near Perinet, where the Leningrad series originated, we did not encounter this species.

The type data for *H. madagascarensis* state that it was collected in the Tanala Forest, and this data plus the close relationship to the terrestrial species taken later in our expedition suggest that *H. madagascarensis* may also be terrestrial.

*Material examined.* MADAGASCAR, Tamatave Province, 4 apterous males, 2 apterous females, Perinet, XII-1932 (JTPC; exchange from Zoological Institute, Leningrad).

#### CHECKLIST OF *HYDROMETRA* SPECIES OCCURRING IN MADAGASCAR

All of the species below are endemic to Madagascar with the exceptions of *H. carayoni* Poisson, described from the Camaroons, and *H. albolineolata* Reuter, a species widely distributed in Africa. We have not been able to confirm the presence of *H. albolineolata* in Madagascar, even though we made collections on the Ankaratra Range in the vicinity of Manjakatempo, a locality from which this species was previously reported (Poisson, 1948). Our determination of *carayoni* is uncertain because we have not been able to examine the type of this species.

<i>Species</i>	<i>Distribution in Madagascar</i>
<i>H. albolineolata</i> Reuter 1882	Manjakatempo (Ankaratra)
<i>H. bifurcata</i> Hungerford and Evans 1934	Widespread
<i>H. carayoni</i> (?) Poisson 1948	Perinet
<i>H. cavernicola</i> J. and D. Polhemus n.sp.	Mt. d'Ambre
<i>H. fanjahira</i> Hungerford and Evans 1934	Widespread
<i>H. isaka</i> Hungerford and Evans 1934	Widespread
<i>H. madagascarensis</i> Hungerford and Evans 1934	Eastern rain forest region
<i>H. phytophila</i> J. and D. Polhemus n. sp.	Mt. d'Ambre

#### *Hydrometra aberrans* Hungerford and Matsuda Figs. 10-12

*Hydrometra aberrans* Hungerford, H. S. and R. Matsuda, 1961. J. Kansas Entomol. Soc. 34:62 (unique female type from Selangor, Malaysia).

*Discussion.* Years ago one of us (JTP) studied a small series of *Hydrometra* from Thailand in the California Academy of Sciences that contained both typical *H. aberrans*, with its distinctive thoracic tubercle in the females, and examples of another quite similar but atuberculate "species." At the time it was hypothesized that the females might be polymorphic forms of a single species, because a detailed examination of every characteristic that could possibly separate them revealed only the bizarre pronotal tubercle of the *aberrans* form, and only a single male form was present. This hypothesis was confirmed when we very fortunately obtained a good series of both morphs plus an intermediate form from a single population in the swamp forests of Johor, peninsular Malaysia.

A careful examination of the females reveals that in addition to the "normal" atuberculate female and the bizarre *aberrans* form there is yet another morph that has a small "button," appearing as an incipient tubercle in the same location on the pronotum as the long process of the *aberrans* form (Figs. 10-12). We have found this form in the Johor series, and in another female from Thailand. As far as we know, this remarkable polymorphism is without parallel in the aquatic Heteroptera.



We have had great difficulty in distinguishing the atuberculate morphs of *H. aberrans* from individuals of the closely allied *H. longicapitis* Bueno, which occurs sympatrically over much of the same geographical range. Our initial inclination was to consider the two species synonymous, but N. M. Andersen (pers. comm.) has stated that he believes these species are distinct, and that there are in fact other undescribed species from Indochina in this same tightly allied complex. Hungerford and Matsuda (1961) discussed the separation of *H. longicapitis* and *H. aberrans*, citing four points of difference. Setting aside 1, the conspicuous caudal pronotal projection of the *aberrans* form, these are discussed in turn for females only, the males being monotonous in all series we have seen and not exhibiting any discernable polymorphisms.

2. Body size: The body of *H. aberrans* (from Malaysia) was said to be larger than that of *H. longicapitis* (from Thailand). We have a small female from Chiang Mai, Thailand but we also have females of equal size for both forms from other series taken in both Thailand (Khao Yai Nat. Pk.) and Malaysia (Johor); most specimens are of similar size regardless of locality.

3. Contour of the abdomen: The type of *H. aberrans* has the abdomen curved upward, rising to the distal margin of tergite V (fourth visible), then bent so that tergites VI and VII are horizontal (see fig. 4 in Hungerford and Matsuda, 1961). The abdomen of *H. longicapitis* was said to be curved over all of its length. All of our "*aberrans*" females are the same as *H. longicapitis* in this regard, except for one female with an incipient pronotal tubercle from Malaysia in which the abdomen is not entirely curved but is instead the same as shown for the type of *H. aberrans*. This appears to constitute yet another polymorphism in the females of this species.

4. Width of the abdominal tergites: These were said to be broader in *H. aberrans*, but we find this character to be variable in the series at hand, and the two forms are clearly not separable on this basis.

The characters previously used to define these species are thus rather weak and variable. Presumably Andersen's future investigations will produce less ambiguous species concepts based on a more thorough character analysis.

We have reviewed a file of correspondence between Dr. C. H. Fernando, Mr. P. B. Karunaratne and Prof. H. B. Hungerford, sent for study by Dr. K. V. Krombein along with the associated Karunaratne collection of Malaysian Hydrometridae (USNM). In a 1963 letter Hungerford stated that he had received from Fernando two macropterous females of *H. aberrans*, one with the pronotum like the type, the other with the pronotum normal! Thus within two years after the original description Hungerford recognized that polymorphism existed in this species, but apparently neither he nor any of the other workers involved ever published this discovery.

*Habitat data.* We found *H. aberrans* to be abundant along the margins of smoothly flowing swamp forest streams in the lowlands of southern Malaysia. The insects seemed to frequent small bars of mud or damp sand at the water's edge, and were usually detected when they ran out onto the water at our approach. If pursued they would leave the water and run back up onto the muddy banks, attempting to gain shelter amid roots and streamside vegetation.

*Material examined.* (All in JTPC, and all of the normal atuberculate form unless otherwise noted.) THAILAND. *Chiang Mai Province.* 1 macropterous male, Mae Sa, 16 km NW Chiang Mai, base of Mt. Doi Sutep, XII-23-1981, A. R. Gillogly; 1 macropterous male, 1 micropterous female, Chiang Mai, Lot No. 275, III-1-1962,

D. C. & E. B. Thurman. *Parjinburi Province*. 1 brachypterous female, Kabinburi, XII-2 to 5-1965, Koi Mongkolpanya. *Province uncertain*. 1 macropterous male, 1 macropterous female (*aberrans* form), 2 brachypterous females (1 *aberrans* form; 1 "incipient tubercle" form), Khao-Yai Nat. Pk., 750 m, VII-26-1962, E. S. Ross, D. Q. Cavagnaro (JTPC, CAS). INDONESIA. *Sumatra Utara Province*. 1 brachypterous female, Dolok Merangir, E. W. Diehl. MALAYSIA. *Johor*. 11 brachypterous males, 7 brachypterous females (2 *aberrans* form, 2 "incipient tubercle" form), swamp forest stream, 61 km NE of Johor Bharu on Mersing Road, CL 2220, X-16-1986, J. T. & D. A. Polhemus; 14 brachypterous males, 2 brachypterous females (1 "incipient tubercle" form), swamp forest stream, 25 km W of Sedili Besar, 20 m, CL 2218, X-16-1986, J. T. & D. A. Polhemus; 2 brachypterous males, 1 brachypterous female, Sungai Wan Tenga, XI-1-1968, J. I. Furtado (USNM, Karunaratne Collection). *Selangor*. 6 brachypterous females (all *aberrans* form), Sungai Klang, Klang Gate, I-14-1962, J. I. Furtado (USNM, Karunaratne Collection).

#### ACKNOWLEDGMENTS

We are indebted to the following individuals, without whose assistance this research could not have been completed: Dr. D. H. (Paddy) Murphy, National University of Singapore, for suggesting that we sample the swamp forest streams of Johor; Dr. N. M. Andersen, Copenhagen, for reviewing the manuscript and providing useful unpublished data; Alan Gillogly for the gift of specimens; Dr. Paul Arnaud for the opportunity to study material in the California Academy of Sciences (CAS); Dr. I. M. Kerzhner for the exchange of specimens from the Zoological Institute of Leningrad; Dr. K. V. Krombein for the opportunity to study material from the Smithsonian Ceylon Insect Project, including the Karunaratne Collection (USNM); Dr. Vincent Razafimahatratra, University of Madagascar, and Dr. Voara Randrianosolo, Parc de Tsimbazaza (TSIM), for their assistance during our stay in Madagascar. Types of new species are deposited in the National Museum of Natural History, Washington, D.C. (USNM); paratypes are held in the J. T. Polhemus collection (JTPC) and the Parc de Tsimbazaza.

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## THREE NEW GENERA AND SIX NEW SPECIES OF NEOTROPICAL COREIDAE (HETEROPTERA)

HARRY BRAILOVSKY

Instituto de Biología, UNAM, Depto. de Zoología, Apdo. Postal #70153,  
México 04510 D.F., México

*Abstract.*—*Meluchamixia olea* (Costa Rica) and *Vivianadema magna* (Peru) are described as new genera and new species and included in the Tribe Nematopodini. *Beutelspachis sanchezi* (Argentina) is described as a new genus and new species and included in the Tribe Acanthocerini. Three new species *Eubule sandracine* (Colombia), *Spartocera melas* (Brazil) and *Sephina quintanarooana* (México) belonging to the Tribe Spartocerini are described. Dorsal view illustrations are provided for all new species, as is a key to the genera of Nematopodini.

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Members of the Tribes Acanthocerini, Nematopodini, and Spartocerini are found primarily in the tropical and subtropical regions of the Western Hemisphere. Three new genera and six new species are described below, based on specimens recently acquired by the author and are part of the ongoing studies relating to neotropical Coreidae.

The following abbreviations are used in the text: American Museum of Natural History (AMNH); British Museum of Natural History (BMNH); California Academy of Sciences (CAS); Instituto de Biología de la Universidad Nacional Autónoma de México (IBUNAM); Instituto Nacional de Pesquisas da Amazonia (INPA).

All measurements are in millimeters.

### **Meluchamixia**, new genus

*Description.* Body large, broad and stout, somewhat depressed. HEAD. Subquadrate, wider than long, declivent, postocular tubercles small, forming smooth curve with eye; antenniferous tubercles wide, not projecting anteriorly and widely separated; tylus projecting anteriorly of antennifers and more elevated than jugum; antennal segment I long, terete and a little stouter than II; II long, slender, terete and a little shorter than I; III the smallest and conspicuously dilated both externally and internally; IV slender, slightly curved, fusiform and longer than I; labium short, just reaching the middle of intermediate coxae and with segment I stouter and reaching the anterior margin of the prosternum. THORAX. *Pronotum.* Very declivent, wider than long, rugose, with indistinct callar region; collar narrow but distinct; anterior margin slightly rounded; frontal angles obtuse, curved and short; anterolateral margins nodulose and obliquely straight; humeral angles produced laterally into broad spine exposed and projected, enlarged and with the apex subacute and slightly inclined backwards; posterolateral margins nodulose and posteriorly smooth; posterior margin smooth, slightly curved and with the posterior angles rounded. *Legs.* All femora with dorsal surface smooth, rounded and ventrally armed at least distally with spines; posterior femora incrassate, with spines at least along ventral surface, increasing in size distally; anterior and intermediate tibiae more or less terete, unarmed and sulcate;



posterior tibiae slightly dilated internally and externally, internal dilation armed with at least five large spines. Mesosternum lacking median longitudinal groove; meta-thoracic scent gland opening placed relatively laterally. Scutellum wider than long and transversely striate. ABDOMEN. Broad, widest point at segment IV, posterior angles rounded or angulate but not produced into a sharp spine; spiracles relatively transverse, situated nearer anterior than lateral margins.

*Type species.* *Meluchamixia olea*, new species.

*Etymology.* Named for the similarity of its appearance to *Melucha*; feminine.

*Distribution.* Costa Rica.

*Discussion.* This genus will not run to any known genus in the key to Nematopodini (O'Shea, 1980). The only genera in that key with the posterior tibiae dilated both internally and externally are *Thasus* and *Melucha*, and even in that group the dilations are marked and not slight like this new genus. The only Nematopodini with the calli of the pronotum entire, the anterolateral margins of pronotum markedly nodulose, and the humeral angles produced laterally into a sharp spine as long as the head is the recently described *Thasopsis* O'Shea (1980). In *Thasopsis* antennal segment III and the posterior tibiae are terete and the bucculae are squared or circular. In *Meluchamixia* the antennal segment III is markedly dilated, the posterior tibiae slightly dilated and the bucculae are wide, slightly exposed and are diminished towards the posterior gular region.

In *Thasus* the posterior angles of abdominal segments are armed with long spines and the antennal segment III is markedly dilated and longer than in *Meluchamixia*.

In *Melucha* and *Meluchamixia* the posterior angles of abdominal segments are unarmed or armed with a short spine. Antennal segment III of *Melucha* is longer, terete and sometimes very slightly dilated and the posterior tibiae are unarmed or armed with only one tooth; on *Meluchamixia* the internal dilation of the posterior tibiae is armed with at least five spines and antennal segment III is extremely short and dilated.

### ***Meluchamixia olea*, new species**

Fig. 1

*Diagnosis.* Individuals of relative large size, robust, with the antennal segment III markedly dilated and the posterior tibiae slightly dilated.

*Description.* DORSAL COLORATION. Head pale hazel with the preocellar region yellow and the tubercular ocellus brownish; antennal segments I to IV orange hazel; pronotum olive green, except the posterior border and two wide longitudinal bands that run obliquely from the anterior border to the posterior border which are yellowish ochre; pronotal nodules reddish gray to shiny black; scutellum yellow and with the middle region of the posterior third olive green; clavus and corium olive green with the veins, costal border, apical border and the claval suture yellow ochre or orange hazel; hemelytral membrane hazel amber with the veins slightly obscured; connexival segments orange hazel. VENTRAL COLORATION. Pale orange yellow; labium orange hazel with the apex of segment IV black; coxae and trochanters yellow; anterior femora with the ventral face yellow and orange and dorsally olive green; middle and posterior femora yellow and orange and only the third part of dorsal face olive green; femoral teeth of all legs shining black or unicolorous with the ventral surface; tibiae and tarsi dark orange or dark hazel and with the metatibiae somewhat blackened.



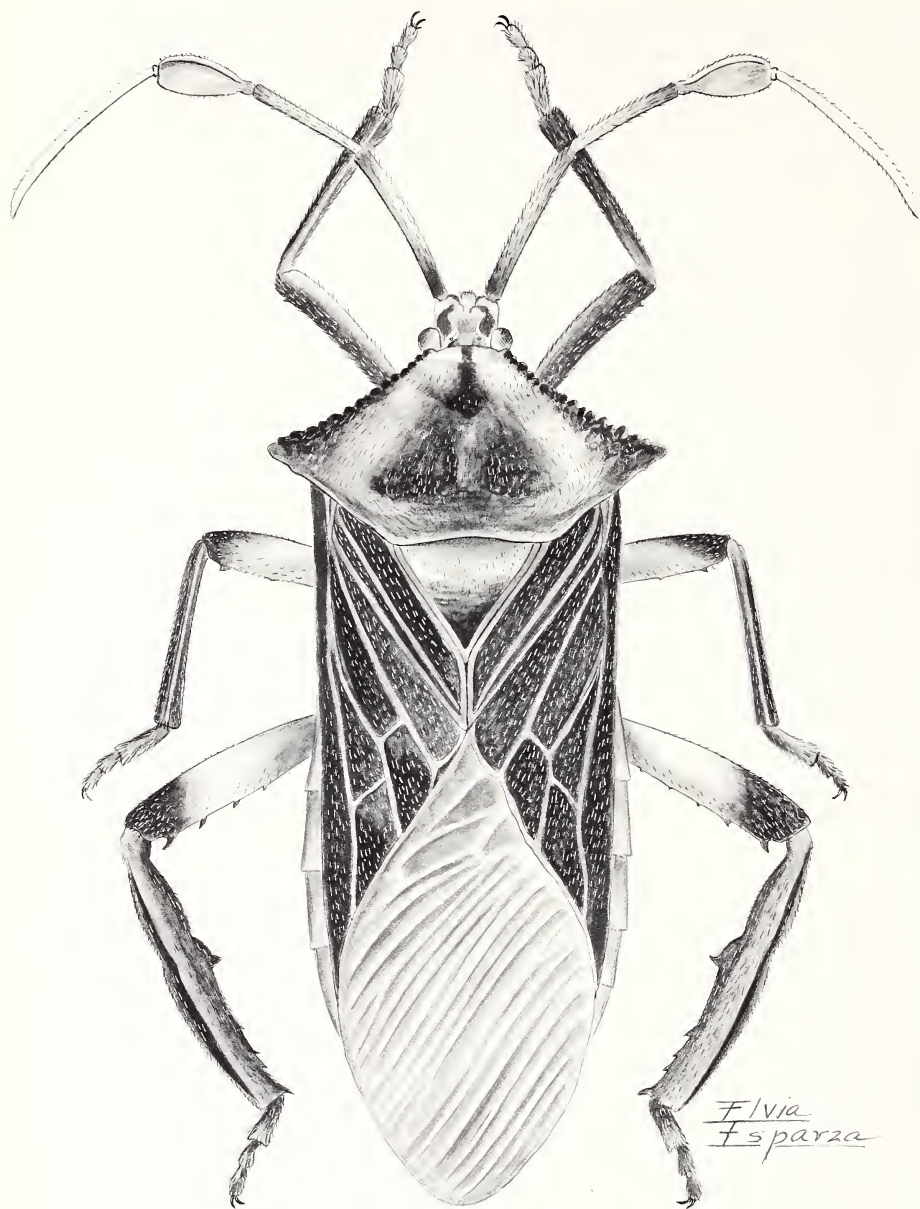


Fig. 1. *Meluchamixia olea*.

*Measurements.* Length head: 1.52; interocellar space: 0.98; width eyes: 2.73; length antennal segments: I, 4.71; II, 3.72; III, 2.81; IV, 6.23. Length pronotum: 6.69; width across frontal angles: 2.95; width across humeral angles: 12.47. Length scutellum 3.72; width: 4.10. Total body length: 24.78.

*Holotype.* Female. COSTA RICA: Provincia Cartago: Turrialba, La Suiza, 28.XII.1977, P. C. Marin. Deposited in IBUNAM.

*Etymology.* From the Latin *olea*, olive, named for its olive green dorsum.

### **Vivianadema**, new genus

*Description.* Body large, broad, stout, somewhat depressed. HEAD: Subquadrate, wider than long, declivent, postocular tubercle small, forming smooth curve with eye; antenniferous tubercles wide, not projecting anteriorly and widely separated; antennal segment I long, terete, a little stouter and longer than II and slightly sulcate; II prismatic, and slightly shorter than III; segment III slightly dilated both externally and internally; labium short, just reaching the middle of intermediate coxae and with segment I stouter and reaching the anterior margin of the prosternum. THORAX. *Pronotum.* Very declivent, wider than long and finely dotted and transversely striate; callar region indistinct and entire; collar narrow but distinct; anterior margin slightly rounded; frontal angles short and not exposed; anterolateral margins markedly nodulose and concave; humeral angles produced laterally into wing-like projections, very broad, elevated and with the apex rounded; posterolateral margins entirely nodulose; posterior margin smooth, slightly curved and with the posterior angles rounded. *Legs.* Anterior and intermediate femora ventrally armed with one row of small internal teeth; posterior femora with the ventral surface carinate and armed with one row of internal, large, and acute spines; dorsal surface of all femora carinate at least distally; all tibiae unarmed, markedly dilated both internally and externally; tarsal segments I and II prismatic; tarsal segment III rounded. Mesosternum lacking median longitudinal groove; metathoracic scent gland opening placed relatively laterally. Scutellum wider than long, transversely striate. ABDOMEN. Broad, widest point at segment IV and V, posterior angles armed with a short spine; spiracles relatively transverse, situated nearer anterior than lateral margins.

*Type species.* *Vivianadema magna*, new species.

*Etymology.* Named for Viviana Somoza Signoret; feminine.

*Distribution.* Peru.

*Discussion.* This genus is closely related to *Thasus*, agreeing with it in body size (over 30 mm long), the posterior tibiae markedly dilated both internally and externally, and the spines on the posterior angles of the abdominal segments. The two genera are readily separable on a number of features. In *Vivianadema* antennal segment III is longer than II, the posterolateral margins of the pronotum are nodulose, and the humeral angles are developed into huge wing-like processes. In *Thasus*, antennal segment II is longer than III, the posterolateral margins are smooth, and the humeral angles are rounded or well produced laterally, but never disposed upwards to form a wing-like process.

### **Vivianadema magna**, new species

Fig. 2

*Diagnosis.* Individuals of large size, robust, with antennal segment III longer than II, the posterolateral margins of the pronotum nodulose, and the humeral angles developed into huge wing-like processes.

*Description.* COLORATION. Head dorsally, including antennal segments I to III

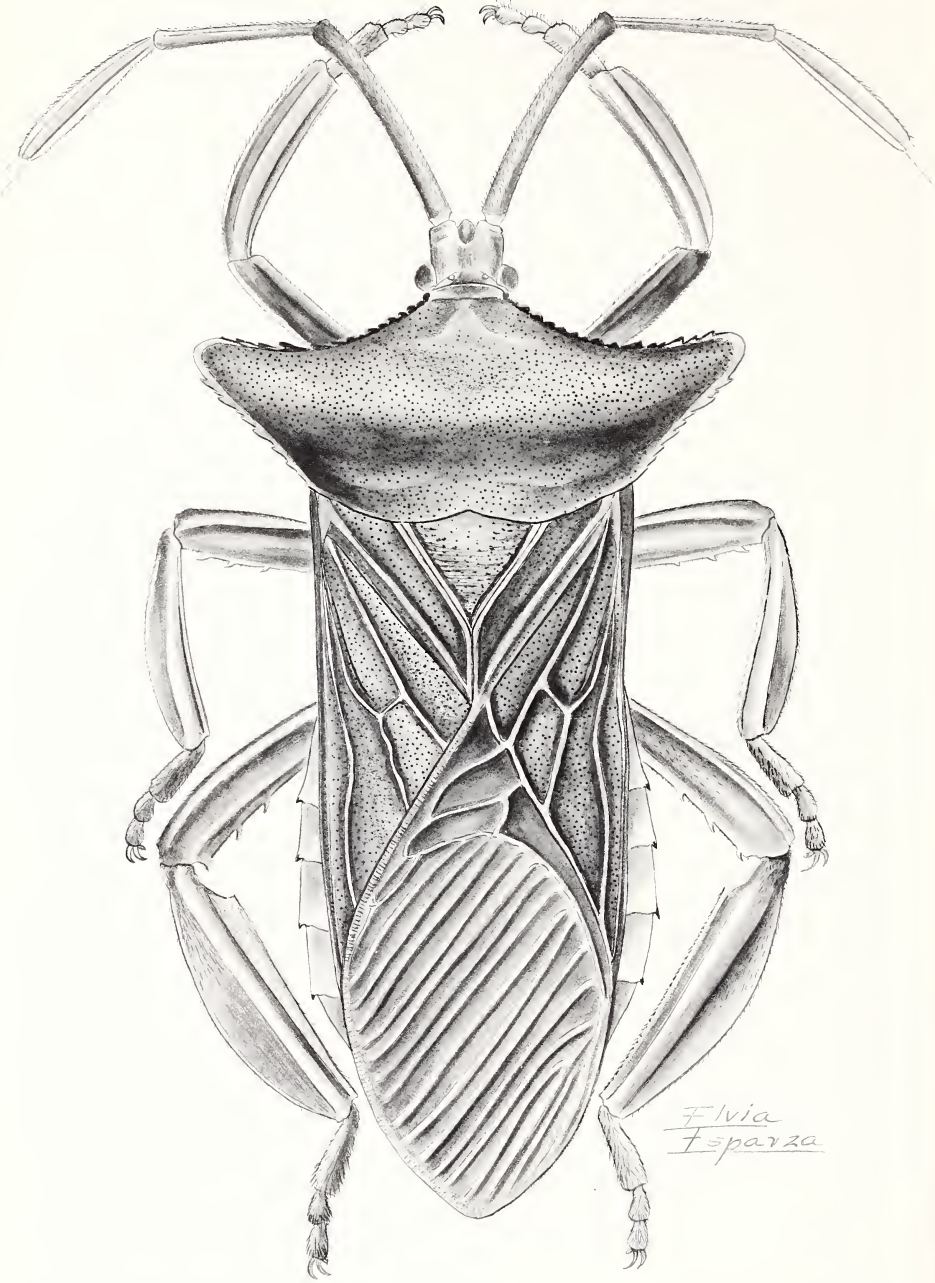


Fig. 2. *Vivianadema magna*.



*Description.* Body relatively small, robust. HEAD. Quadrate, wider than long, conspicuously declivent, postocular tubercles prominent; eyes small and sessile; antenniferous tubercles large, well separated, projecting distinctly anteriorly of tylus, with distinct large and stout spine on external surface; antennae relatively short, stout and granulated on segment I to III; antennal segment I markedly robust, terete, longer than II and IV; segment II very short, stout, terete, and shorter than IV; segment III the longest, markedly dilated both externally and internally; IV robust, fusiform, and



shorter than I; bucculae short, reaching the middle of gular region; labium short, just reaching the middle of intermediate coxae and with the segment I stouter and reaching the anterior margin of the prosternum. THORAX. *Pronotum*. Slightly declivent, wider than long; callar region distinct; collar narrow; all margins relatively smooth except anterolateral margin with small tubercles; frontal angles well developed into large, acute projections that reach the postocular tubercles; humeral angles rounded; posterolateral margins obliquely straight; posterior margin slightly curved and with the posterior angles rounded; surface densely punctate and transversely striate. *Legs*. All femora at least slightly incrassate; posterior femora more incrassate; all femora with subdistal spines on ventral surface and dorsally smooth; anterior and intermediate tibiae terete, sulcate, and unarmed; posterior tibiae slightly flattened, widest at midpoint, armed with small teeth along internal margin. Mesosternum with deep median sulcus; metathoracic scent gland opening placed relatively laterally; posterior lobe of metapleuron of female lacking process. Scutellum a little wider than long, rugose and transversely striate. ABDOMEN. Relatively broad, widest point at segments IV and V, posterior angles unarmed; connexivum exposed; spiracles closer to anterior than lateral margins; plica on seventh sternite curved.

*Type species. Beutelspacoris sanchezi*, new species.

*Etymology*. Named for Dr. Carlos Beuteslpacher, lepidopterist from IBUNAM, and *coris*, bug; masculine.

*Distribution*. Argentina.

*Beutelspacoris* shows a close relationship to *Thlastocoris* Mayr in many ways; the antenniferous tubercles are armed laterally with a large spine, the body length is greater than 8 mm and less than 20 mm, the humeral angles of the pronotum are rounded, the posterior lobe of metapleuron lacks a process, the connexivum is exposed, and the posterior angles of the abdominal segments are unarmed.

*Beutelspacoris* differs from *Thlastocoris* in the shape of the antennal segments, including segment II which is very small and stout and III which is dilated both internally and externally; the head is quadrate and conspicuously declivent and the median sulcus of the mesosternum is very deep. In *Thlastocoris* antennal segment II is the longest, III is not dilated, the head is subquadrate, and the mesosternum has a shallow longitudinal depression.

### ***Beutelspacoris sanchezi*, new species**

Fig. 3

*Diagnosis*. Individuals of medium size, relatively slender, with the head quadrate and conspicuously declivent and antennal segment III longer than II.

*Description*. DORSAL COLORATION. Head including antennal segments I and II shining orange; antennal segments III and IV reddish brown; pronotum shining orange and with the following areas black: posterior margin, posterior half of the anterolateral margins, humeral angles, and a small thin longitudinal band running from the middle to the posterior border; scutellum reddish brown; clavus yellow ochre; corium yellow ochre and with the mesial area of the endocorium dark; hemelytral membrane brown amber with the veins and the basal angle somewhat darker; connexivum orange with the punctations reddish and the superior border reddish brown; abdominal segments shining orange and with the genital segments orange and reddish brown. VENTRAL COLORATION. Shining orange and with the fol-

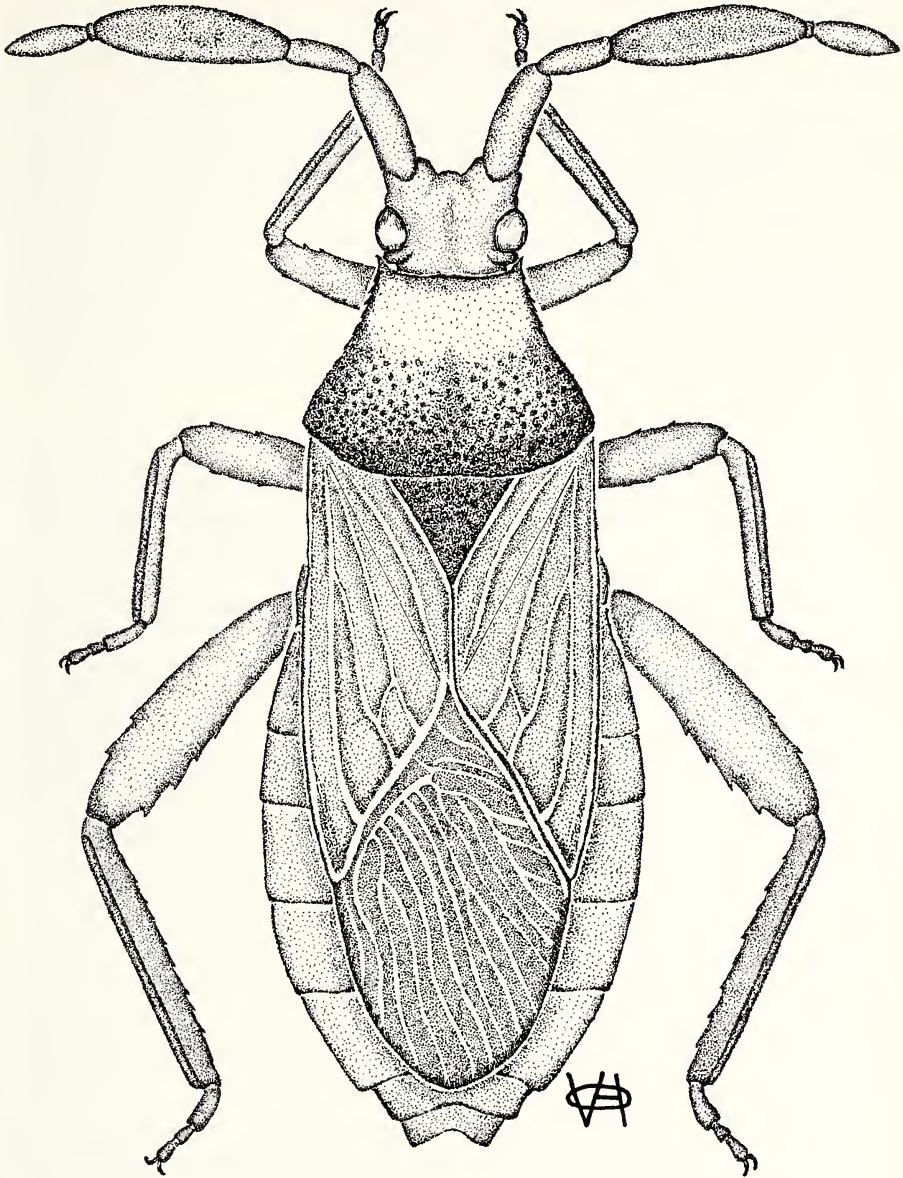


Fig. 3. *Beutelspacoris sanchezi*.

lowing areas black: apex of the labial segment IV, a long portion of the propleura, a longitudinal band that runs across the dorsal margin of the mesopleura and meta-pleura, a square spot that surrounds the abdominal spiracles III and IV, and two irregular mesosternal spots located laterally of the central line between the procoxae

and mesocoxae; metathoracic scent gland lobes pale orange brown; abdominal spiracles yellow ochre; coxae, trochanters and femora shining orange; anterior and middle tibiae dark orange; posterior tibiae reddish brown to black; tarsal segments dirty orange.

*Measurements.* Length head: 1.36; interocellar space: 0.62, width across eyes: 1.88; length antennal segments: I, 1.70; II, 0.93; III, 2.63; IV, 1.06. Length pronotum: 2.54; width across frontal angles: 1.76; width across humeral angles: 3.74. Length scutellum: 1.27; width: 1.36. Total body length: 12.55.

*Holotype.* Female. ARGENTINA: Santiago del Estero: Lago Muyo, III, 1957, R. Golbach. Deposited in AMNH.

*Etymology.* Named for Dr. Victor Sánchez Cordero, a young zoologist from IBUNAM.

#### **Eubule sandaracine**, new species

Fig. 4

*Description.* Individuals of medium size, elongate, relatively slender, covered with a dense whitish pilosity of mostly appressed hairs and some erect hairs, the entire body, and specially the ventral surface appearing white tomentose. DORSAL COLORATION. Black with a reddish brown tone and with the following areas orange: space between ocelli and eyes, the anterolateral margins, humeral angles and the posterolateral margins of the pronotum, apex of the scutellum, inferior angles of the claval commissure, anterior half of the costal border and most of the apical border of the corium, connexival segments and the posterior margin of abdominal segments VI and all of abdominal segment VII; hemelytral membrane dark. VENTRAL COLORATION. Dark reddish brown and with the following areas orange: lateral margins of the propleura, posterior margins of prothorax and metathorax, pleural margins of the abdomen and paratergites VIII and IX; prothorax, mesothorax, and metathorax with shining black spot; abdominal spiracles surrounded with reddish brown. Labium attaining or slightly exceeding the base of metathorax and with the first segment stouter and projecting beyond the anterior margin of the prosternum; pronotum nearly hexagonal with the anterolateral margins nodulose, straight and with an oblique trajectory; humeral angles rounded and not exposed; pronotal disc striate and punctate, except for the nearly smooth callar region; middle third of pronotal disc with two raised keels on each side of the medial line and with a shallow groove between them; transverse keel thickened; base of scutellum with a protruding transverse fringe; hemelytral membrane with a few scattered cells and numerous bifurcate veins; channels of the scent gland short; legs unarmed; acetabula and prothorax with scattered punctures.

*Measurements.* Female. Length head: 1.20; interocellar space: 0.69; width across eyes: 2.08; length antennal segments: I, 2.85; II, 3.28; III, 2.60; IV, 3.96. Length pronotum: 4.09; width across frontal angles: 1.79; width across humeral angles: 7.18. Length scutellum: 2.41; width: 2.54. Maximum width across abdomen: 9.50. Total body length: 19.88. Male. Length head: 0.98; interocellar space: 0.67; width across eyes: 1.92; length antennal segments: I, 2.79; II, 3.16; III and IV mutilated. Length pronotum: 3.47; width across frontal angles: 1.61; width across humeral angles: 6.13. Length scutellum: 2.17; width: 2.23. Maximum width across abdomen: 7.70. Total body length: 18.70.



*Etymology.* From the Greek *sandaracinos*, orange colored.

*Holotype.* Female. COLOMBIA: 3 mi W Villavicencio, Meta, 920 m, 11.III.1955. E. I. Schlinger and E. S. Ross. Deposited in CAS.

*Paratype.* Male. Same date. Deposited in IBUNAM.

*Discussion.* *Eubule sandaracine* is closely related to *E. farinosa* (Dallas) and *E. scutellata* (Westwood), resembling them in both size and general habitus. The new species is readily distinguishable by its longer labium reaching the base of metathorax, the humeral angles which are rounded and not exposed and the strongly elevated keel on the pronotal disc. In the other two species the labium is short, attaining or only slightly exceeding the base of the mesothorax, the humeral angles are subacute and slightly exposed, and the pronotal disc has a small keel. Furthermore the dorsal coloration is quite distinct.

***Spartocera melas*, new species**

Fig. 5

*Description.* Individuals of medium size and stout body, with the greatest width across abdominal segments IV–V. **COLORATION.** Black, with the humeral angles and a small, irregular, yellow spot located on the middle of the corium, and with the following areas orange brown: a narrow, short, longitudinal, medial band running from the posterior margin almost to the middle of the pronotum, the anterior third of the lateral margins of the scutellum and some irregular spots dispersed on the abdominal sternites; connexival segments and pleural margins of the abdomen black and with the following areas orange brown: anterior angles, a short longitudinal band near the posterior angle, the posterior angles of segments VI and VII and a small discoidal spot at the base of connexival segments V to VII; abdominal tergites black and with VII orange yellow with a narrow, black, longitudinal, medial band running from the posterior margin to the middle; hemelytral membrane amber, translucent and with the basal third and some cells blackened; a small, dark, orange spot located near the internal face of each abdominal spiracle (genital segments of the female are variegated with orange and brown). Labium conspicuously short, broad and reaching the posterior margin of the procoxae (in the female reaching the anterior margin of the mesothorax); pronotum nearly hexagonal with shallow punctures apparent and located on the middle and posterior portions of the disc; anterior portion of pronotal disc pubescent and nearly smooth; anterior border slightly concave; anterolateral border undulate, with an oblique trajectory and with black erect bristles; humeral angles more or less exposed in dorsal view, squared and right angled; posterolateral border undulate and smooth; posterior border nearly straight; hemelytral membrane reticulate with numerous cells; connexival segments exposed, directed upward and not covered by the membrane; prothorax and the meso- and metathoracic acetabulae densely punctate; femora and tibia covered with short, erect black bristles; antennal segment I stout, thickened, cylindrical, and somewhat curved outwards.

*Measurements.* Female. Length head: 1.14; interocellar space: 0.68; width across eyes: 2.10; length antennal segments: I, 2.32; II, 2.48; III, 2.29; IV, 2.72. Length pronotum: 3.90; width across frontal angles: 1.97; width across humeral angles: 6.95. Length scutellum: 1.98; width: 2.41. Maximum width across abdomen: 9.30. Total body length: 19.00. Male. Length head: 1.17; interocellar space: 0.74; width across eyes: 2.10; length antennal segments: I, 2.35; II, 2.48; III, 2.41; IV, 2.72. Length





Figs. 4-6. 4. *Eubule sandaracine*. 5. *Spartocera melas*. 6. *Sephina quintanarooana*.

pronotum: 3.51; width across frontal angles: 1.84; width across humeral angles: 6.23. Length scutellum: 1.91; width: 2.31. Maximum width across abdomen: 9.30. Total body length: 17.34.

*Etymology.* From the Greek, *melas*, black, indicating the practically all black coloration.

*Holotype.* Male. BRASIL: Para: Brabanga, 26.V.1978, M. F. Torres. Deposited in INPA.

*Paratype.* Female. Same date. Deposited in IBUNAM.

*Discussion.* This is a very distinctive species within the genus *Spartocera*. Not only is the coloration completely different from that found in the other species, but the peculiar expanded, squared, humeral angles and the short, stout labium are unique. Most of the species in the group have light or orange coloration and the labium reaches the middle of the metathorax or the middle or posterior margin of the metathorax.

### ***Sephina quintanarooana*, new species**

Fig. 6

*Description.* Individuals of medium size, robust, with the greatest width across abdominal segments IV–V, the body covered with a fine, dense pilosity composed of black and golden, generally erect hairs. DORSAL COLORATION. Head black, with the space between the ocellus and eyes ochre yellow; antennal segments I–III black with a pilosity comprised of long erect hairs; antennal segment IV reddish brown, slightly paler than I to III and covered by short decumbent hairs; pronotum including the anterolateral margins and the humeral angles black and with the following areas bright orange: the anterior margin including the collar and a relatively narrow arched fringe, running from the raised areas on the anterior third of the disc to the arms of the posterolateral margins; scutellum black with the apex dark orange; clavus bright orange and only the claval commissure and claval margin black; corium black, with the anterior half of the costal margin dark orange with two subdiscoidal spots bright orange, one very large, the other very small and located on the middle third of the apical margin; membrane dark brown and with the basal angle blackened; connexival segments III to VII bicolorous, with the anterior third bright orange and the remaining  $\frac{2}{3}$  black, segments VIII and IX with the anterior  $\frac{2}{3}$  orange and the remainder black; abdominal tergites orange, with the middle third of the posterior margin black and segments VII to IX orange, with all of the posterior margin black. VENTRAL COLORATION. Head including the bucculae orange yellow and only a fringe joining the jugum pale brown; labium black with a discontinuous, thin, lateral fringe running along both sides from the medial line of each segment, the basal joint of segment II and the intersegmental area of segments III–IV with an orange brown tint; prothorax orange with only an irregular pleural spot black; mesothorax and metathorax black with the following areas orange: acetabula, the posterior margin of each segment, the upper margin of the metapleura and the mesosternum and metasternum; scent gland orange with the lobes black; legs reddish brown; abdomen black and with the following areas orange: the larger part of the middle third of the anterior margin of sternite abdominal III, a narrow longitudinal fringe that runs along the medial line of the sternites III to VI (the basal third always black), a series of irregular spots on the sides of the medial line and practically all the posterior margin and

middle third of the sternite VII; pleural margin of the abdomen with the posterior third black and the remainder, including the areas surrounding the spiracles, orange; spiracles bordered by black; gonocoxite I black; paratergite VIII orange and with the spiracle and an apical discoidal spot brown; paratergite IX with the basal half black and the rest orange and with the internal face light brown. Labium reaching near the middle of the metathorax and with the segment I stouter and projecting beyond the anterior margin of the prosternum; pronotum nearly hexagonal with punctures apparent and shallow; anterior portion pronotal disc sloping and medially split forming two tubercles that in lateral view are not conspicuously raised; humeral angles rounded and not exposed; posterior border of the metathorax slightly swollen and rounded.

*Measurements.* Length head: 1.29; interocellar space: 0.68; width across eyes: 2.21; length antennal segments: I, 2.43; II, 2.66; III, 2.12; IV, 3.19. Length pronotum: 4.10; width across frontal angles: 2.25; width across humeral angles: 7.60. Length scutellum: 2.43; width: 3.05. Maximum width across abdomen: 9.50. Total body length: 20.03.

*Etymology.* Named for the Mexican State of Quintana Roo.

*Holotype.* Female. MEXICO: Quintana Roo: Felipe Carrillo Puerto. Laguna de Chunyaxche, 4.VII.1985, J. Antonio. Deposited in IBUNAM.

*Discussion.* In a previous paper, Brailovsky and Sanchez (1983) included six Mexican species in the genus *Sephina*, and this new taxon represents the seventh species which is very close to *S. geniculata* from Costa Rica. Both species have a large subdiscoidal yellow or orange spot in the middle third of the apical margin of the corium and a bicolourous connexivum. *Sephina geniculata* has the apex of the femora and the base of the tibia yellow, the anterolateral margins of the pronotum orange red and the hemelytral membrane with yellow discoidal spots which are absent in *S. quintanarooana* in which the femora, tibiae, and anterolateral margins of the pronotum are entirely black.

#### ACKNOWLEDGMENTS

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STUDIES ON THE GENUS *APHODIUS* OF THE UNITED STATES  
AND CANADA (COLEOPTERA: SCARABAEIDAE). VIII. A NEW  
SPECIES FROM NORTHEASTERN NORTH AMERICA

JOHN COOPER AND ROBERT D. GORDON

Invertebrate Zoology Division, National Museum of Natural Sciences,  
National Museums of Canada, Ottawa K1A 0M8, Canada and  
Systematic Entomology Laboratory, BBII, Agricultural Research Service, USDA,  
% U.S. National Museum of Natural History, Washington, D.C. 20560

*Abstract.*—A new species of dung feeding Scarabaeidae, *Aphodius aenictus*, is described from southeastern Canada and northeastern United States. It is integrated into the existing key to eastern species of *Aphodius*, and pertinent diagnostic characters are illustrated.

We here describe an *Aphodius* species, not included in the key to the eastern North American fauna (Gordon, 1983), to make the name available for inclusion in the Scarabaeidae part (Cooper, in press) of the identification manual of Canadian insects and arachnids.

Type specimens are deposited in the following collections (acronyms are those used in the text): Canadian National Collection, Ottawa, Ontario (CNC); Henry Howden, Carleton University, Ottawa, Ontario (HH); and U.S. National Museum, Washington, D.C. (USNM).

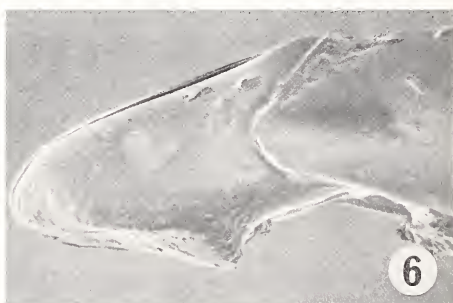
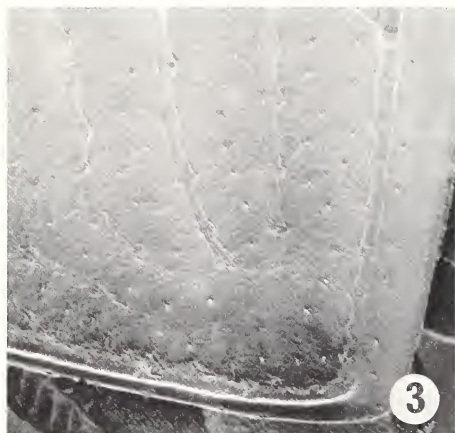
The key to species in Gordon (1983) is modified to include the new addition as follows.

- 52. Clypeal apex almost semicircular; elytron usually mostly red except sutural margin and lateral 1/3 obscurely or distinctly darkened, red area often variably reduced . . . . . *vittatus* Say  
Clypeal apex emarginate; elytron black, usually with dark red or reddish brown areas, at least on apical declivity . . . . . 56
- 56. Clypeal apex distinctly emarginate in dorsal view (fig. 1); frons lacking median tubercle (fig. 1); elytron with each interval distinctly, finely punctate even on apical declivity (fig. 3); metasternum finely punctate, with row of much coarser punctures on each side converging posteriorly; male fore tibial spur stout, about 0.3 times as long as tibia; minor spur of mid tibia apically truncate; genitalia as in fig. 5 . . . . . *aenictus*, new species  
Clypeal apex very feebly emarginate in dorsal view (fig. 2); head with median tubercle feebly or moderately developed in male (fig. 2), barely evident or lacking in female; elytron with punctures on each interval scarcely if at all discernible on apical declivity (fig. 4); metasternum with mixture of fine and small punctures; male fore tibial spur slender, about 0.25 as long as tibia; minor spur of mid tibia apically pointed; genitalia as in fig. 6 . . . . . *borealis* Gyllenhal

***Aphodius aenictus*, new species**

*Description.* Male, length 4.9 mm, greatest width 2.0 mm. Form elongate, elytra nearly parallel sided. Color black except narrow clypeal apex, small area on antero-





lateral angle of pronotum, apical  $\frac{1}{2}$  of elytron, leg dark reddish brown. Clypeus (Fig. 1) distinctly emarginate apically, surface alutaceous, slightly rugose, with extremely fine punctation, with median, transverse swollen area. Frons (Fig. 1) lacking tubercles; surface shiny, with fine punctures separated by less than to twice a diameter. Eye small, approximately 0.1 width of interocular space. Pronotum convex, not explanate;

surface with intermixed fine, coarse punctures, with narrow, median longitudinal area impunctate; lateral margin slightly arcuate; hind angle not abrupt, approximately 45 degrees; base with distinct marginal bead. Elytron slightly alutaceous except apical declivity strongly alutaceous (Fig. 3); stria distinctly impressed, stria punctures fine, separated by about 3 times a diameter; interval feebly convex, with fine punctures discernable throughout, separated by 1 to 4 times a diameter. Epipleuron with short setae visible from above only in humeral region. Mesosternum not carinate between coxae. Metasternum finely punctate, with row of larger punctures on each side of middle converging posteriorly. Fore tibia tridentate; tibial spur 0.3 as long as tibia, broad, abruptly curved downward at apex. Apices of mid and hind tibiae fringed with short setae of nearly equal length; minor spur of mid tibia 0.4–0.5 as long as major spur, nearly straight, truncate at apex. Hind femur about 0.5 times as long as wide, with fine punctures separated by 1 to 3 times a diameter; hind tarsus as long as tibia, 1st tarsal segment as long as next 3 segments combined. Genitalia as in Figure 5. *Female*: similar to male except fore tibial spur about 0.25 as long as tibia, apex pointed, not abruptly bent downward; minor spur of mid tibia about 0.5 times as long as major spur, curved slightly outward to pointed apex. *Variation*: length 3.8 to 5.0 mm, width 1.8 to 2.4 mm; apical reddish brown area of elytron may extend along the lateral margin to midpoint, or be reduced to a small red spot at apical  $\frac{2}{3}$ , or be lacking altogether.

*Type specimens*. Male holotype, Ontario, Alfred, 10.V.1981, S. Peck R. Anderson, spruce sphagnum bog, moose droppings and predator scats (HH). Allotype (HH), and 14 paratypes, same data as holotype. Paratypes: 2, same data as holotype except date 2.V.1980, S. Peck, moose dung; 3, Pennsylvania, Bear Meadow, 4-29-48, Ford; 2, Pennsylvania, Petersburg, 4-17-48, Ford; 1, Quebec, Kazabazua, July 15, 1967, J. M. Campbell; 1, Quebec, Roberval, May 25, 1939, S. Dumont. (CNC) (HH) (USNM).

*Remarks*. The affinities of *A. aenictus* are with *A. borealis* Gyllenhal, *A. tenellus* Say, and *A. pectoralis* LeConte. The latter species is known only from the Nearctic Region while the other 2 have holarctic distributions. *Aphodius pectoralis* is not included in the modified key because it is a far western species, not a member of the eastern fauna. All 4 species are apparently generalists on surface dung but more or less restricted to forested areas, which means that only the dung of forest dwelling mammals such as deer, moose, and predators can be utilized. The specimens of *A. aenictus* from Alfred, Ontario, were collected from moose dung and "predator scats" in a sphagnum bog; the Pennsylvania specimens may or may not have been taken from a similar habitat, but it is unlikely that the species is restricted to bogs.

*Etymology*. The specific epithet is derived from the Latin *aenigma*, referring to the long undetected presence of this species in North America.

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**METRIOCNEMUS (DIPTERA: CHIRONOMIDAE)—  
AN ECOLOGICAL SURVEY AND DESCRIPTION OF A  
NEW SPECIES**

PETER S. CRANSTON AND DARLENE D. JUDD<sup>1</sup>

Department of Entomology, British Museum (Natural History),  
Cromwell Road, London SW7 5BD, England, and

Entomology Department, Oregon State University,  
Corvallis, Oregon 97331, USA,<sup>1</sup> and

Entomology Department, American Museum of Natural History,  
Central Park West at 79th Street, New York, New York 10024

*Abstract.*—*Metriocnemus yaquina* from Oregon coastal rock pools is described in all life history stages as new to science. The generic diagnosis of *Metriocnemus* is emended and the disparate larval ecologies exhibited within the genus are reviewed and supplemented.

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The immature stages of non-biting midges (Chironomidae: Diptera) occur abundantly in most aquatic biotopes. Of over 5,000 chironomid species world-wide, over 100 occur in marine and intertidal habitats and at least a similar number, exclusively in the more apomorph members of the subfamily Orthocladiinae, have terrestrial larvae. Species of the orthoclad *Metriocnemus* Wulp exhibit one of the broadest spectra of larval habitat, ranging from the margins of running and standing freshwater through plant-held waters (phytotelmata), the hygropetric (thin-water film) zone to apparently fully terrestrial biotopes. The discovery of an undescribed species from a novel habitat, a Pacific coastal rock pool, prompts us to present new data and review the disparate ecologies within the genus. Furthermore, although *Metriocnemus* is a morphologically homogeneous genus, the new species requires emendation to the previous generic concept in all life-history stages.

METHODS

All material examined is microscope slide prepared in Euparal with pupal exuviae mounted on the same slide as the associated adult. Our terminology follows Saether (1980) except where we recognise the hyaline subapical antennal sensillum as a sensillum trichodeum, not a sensillum chaeticum.

Abbreviations for type repositories are: AMNH—American Museum of Natural History, New York, USA; BMNH—British Museum (Natural History), London, UK; CNC—Canadian National Collection, Biosystematics Research Centre, Ottawa, Ontario, Canada.

***Metriocnemus yaquina*, new species**

Figs. 1-4

*Description.* (Measurements in  $\mu\text{m}$  from stated range unless otherwise in parentheses.)



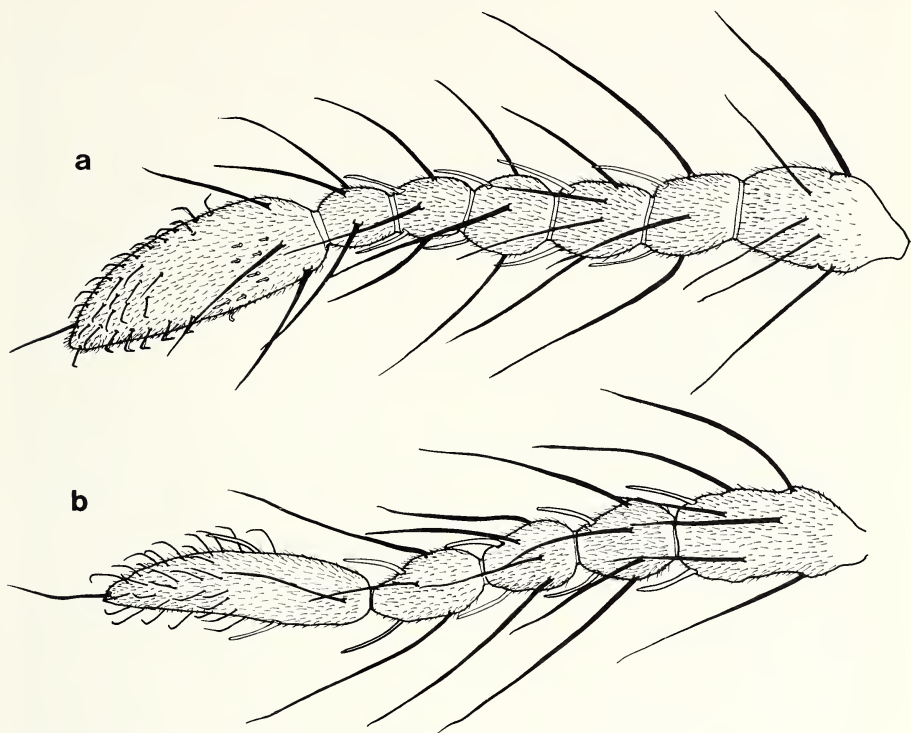


Fig. 1a, b. Antenna of *Metriocnemus yaquina*. a. Male. b. Female.

Male imago ( $N = 2$ ). Body length 3.5–3.7 mm, wing length 1.7–1.8 mm. Brown, with vittae scarcely darker. Antenna (Fig. 1a) with 7 flagellomeres of lengths 72–82, 40–43, 35–36, 36–40, 33–39, 116 (1). Antennal ratio 0.46 (1). Flagellomeres 1–6 with subapical sensilla trichodea subequal in length to flagellomere. Head with 3–5 frontals and 1–2 postorbitals scarcely differentiated from the 3–5 approximate rows of 26–29 temporals. Clypeus with 30–34 densely crowded setae. Eye rounded, without dorsomedian extension. Palp 5 segmented, 1 not measurable, 2–5 respectively 40–42, 83–103, 58–75 and 91–100 long; 3 with subapical group of 4–6 sensilla basiconica not arising from pit.

Thorax with moderately broad anteprenotum and medially separated lobes, each bearing 12–14 lateral anteprenotals. Dorsocentrals strong, anteriorly irregularly in 3–5 rows, posteriorly biserial, totalling 37–41 setae; 19–21 strong, gently curved, biserial acrostichals ending in mid scutum; 10–12 prealars; 2–3 supralars; 15–24 scutellars.

Wing with moderately projecting anal lobe, dense macrotrichia covering membrane with the exception of bare areas beneath  $R_{4+5}$  and  $M_{3+4}$ ; all veins except  $R_{2+3}$  with setae; costa extended about 140–150  $\mu\text{m}$ .  $R_{2+3}$  very faint, running between  $R_1$  and  $R_{4+5}$ , apically evanescent. V.R. 1.07–1.1. Squama with 13–19 setae.

Legs lacking sensilla chaetica and pulvilli. P1 without spur or pseudospurs, P2 with



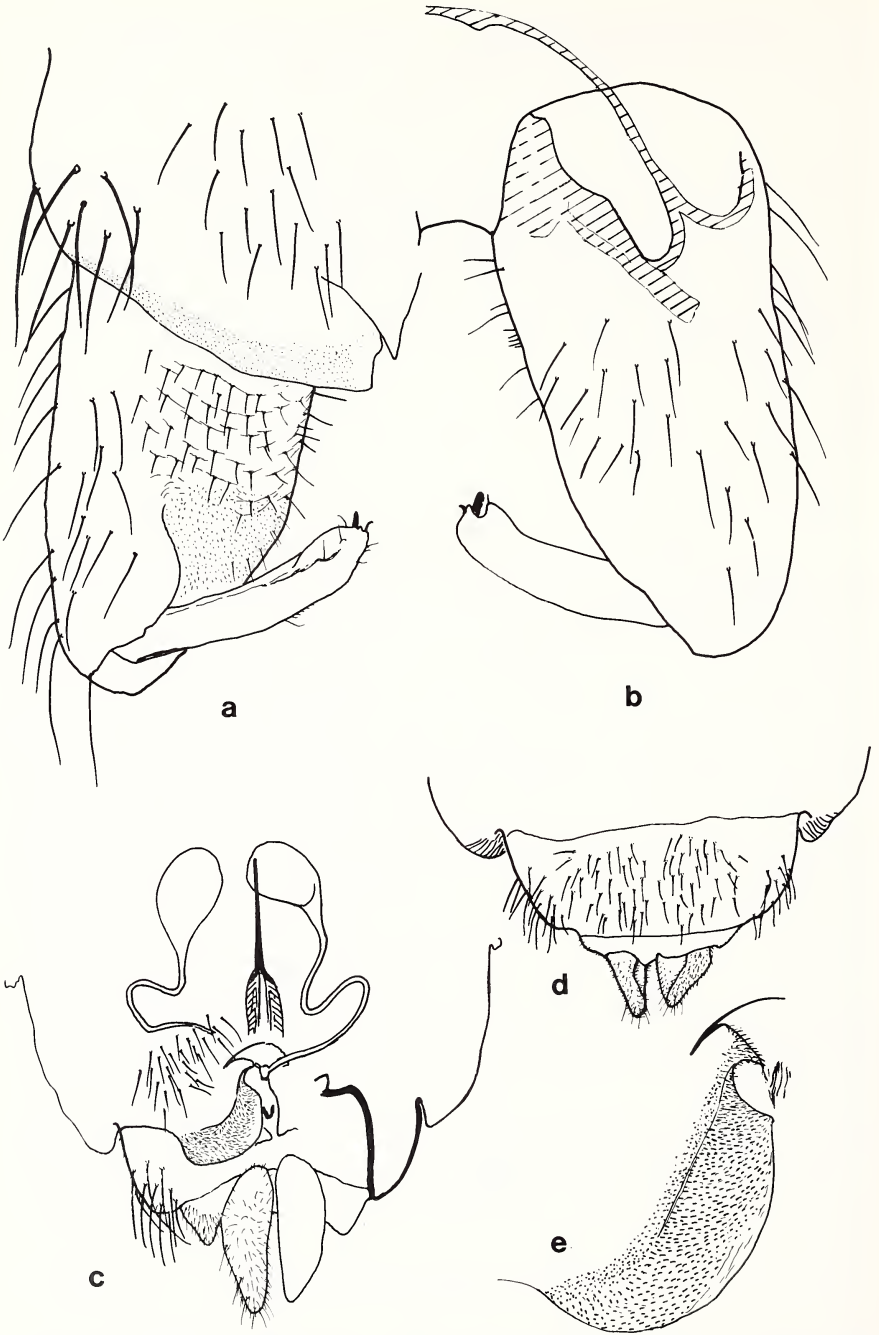


Fig. 2a-e. Genitalia of *Metriocnemus yaquina*. a. Male, left side, dorsal. b. Male, left side, ventral. c. Female, ventral. d. Female, dorsal. e. Gonapophysis VIII, enlarged.

a simple hyaline spur, P3 with stronger spur and comb; both P2 and P3 with dark pseudospurs on apices of tarsomeres 2 and 3. Beard ratio on all legs less than 1. Leg ratios: P<sub>1</sub>, 0.55–0.57, P<sub>2</sub>, 0.45–0.47, P<sub>3</sub>, 0.47–0.53. Abdomen evenly covered with setae. Genitalia (Fig. 2a, b). Tergite IX with even cover of setae. Anal point bare, hyaline, elongate subtriangular. Virga absent. Gonocoxites with widely separated bases, 260–275 long, with volsellae scarcely indicated. Gonostylus 124–128 long, narrow, with shallow subapical crista dorsalis and bluntly rounded megaseta.

Female imago (N = 7 or 8). As male except: Body length 3.4–4.7 mm, wing length 2.0–2.3 mm. Antenna (Fig. 1b) with 5 flagellomeres (nearly complete fusion of 3 and 4 in one specimen) of lengths 89–103, 46–53, 46–50, 46–59, 116–129. Antennal ratio 0.46–0.57. All flagellomeres with subapical sensilla trichodea subequal in length to flagellomere. Temporal setae and clypeus with slightly higher setal counts than male. Palp 5 segmented, 1 not measurable, 2–5 respectively 23–42, 83–106, 50–84, and 96–109 long, 3 with subapical group of 4–6 sensilla basiconica not arising from pit. Thoracic setal counts: 10–16 lateral anteprenotals, 34–42 dorsocentrals, 23–35 acrostichals, 13–21 prealars; 2–3 supralars; 22–50 scutellars. Wing with V.R. 1.19–1.33. Squama with 13–24 setae. Leg ratios: P<sub>1</sub>, 0.52–0.59, P<sub>2</sub>, 0.40–0.46, P<sub>3</sub>, 0.50–0.55. Genitalia (Fig. 1c, d, e). Tergite large, undivided, posteriorly squared off, with 55–65 setae. Gonocoxite IX swollen laterally and bearing 15–20 setae. Gonapophysis VIII comprising only large ventrolateral lobe (Fig. 1e). Gonocoxapodeme very faint, only detectable close to notum. Membrane around vagina and labia present but weakly sclerotised. Tergite IX distinct, with rounded to subtriangular caudolateral extensions. Spermathecae light coloured, somewhat pear shaped with weak neck region, maximum length 86–116, width 53–83, spermathecal ducts curved, almost looping in some examples, ending separately, without bulbs at vagina. Cerci pediform, of maximum length 132–175.

Pupa (N = 10) (Fig. 3). Total length of male 5.0–5.4 mm (2), female 5.8–6.7 mm (8). Thorax yellow-brown, abdomen pale except for yellow apophyses and posterior rows of tergal spines. Cephalothorax (Fig. 3c). Frontal setae absent; ocular area with 1 postocular on inner margin of eye sheath. Antennal sheaths without pearl row. Cephalic area smooth. Thoracic horn absent. Anteprenotum with 2 dorsal and 1 lateral anteprenotal setae, the more dorsal stronger. Precorneals subequal in strength or pcl (anteriormost) slightly stronger, arranged in a triangle. Anteriormost dorso-central (dcl) widely separated from dc2, which is somewhat distant from the adjacent dc3 and 4. All thoracic setae approximately 50  $\mu$ m long and moderately stout. Thorax rugose, wing sheath smooth. Abdomen (Fig. 3a, b). Tergite I rugulose anteriorly, II–IX with anterior transverse bands of small spinules partially extending onto pleurae. Tergites II–VII with posterior transverse single row of 20–30 yellow-pigmented, spine-like tubercles. Conjunctives VII/VIII and VIII/IX with transverse band (3–5 spines wide) of translucent, anteriorly directed curved spines. Sternite I bare, II–III with variable antero-median patch of hair-like spinules, stronger in male pupae, absent in many females). Sternites IV–VIII with anterior transverse band of shagreen, IV–VII with posterior band of anteriorly directed spinules, medially interrupted on IV and often V. Pedes spurii A and B absent. Setation: All abdominal setae moderately developed, distinct. Segment I with 5D, 2L and 1V setae, II–VII with 5D, 4L and 4V setae, VIII with 1D, 4L and 1V seta. Seta D<sub>5</sub> long; L<sub>4</sub> weak. 0 setae absent. Anal lobe (Fig. 3d, e) 420–470 long, bearing three 195–215 long macrosetae, inserted

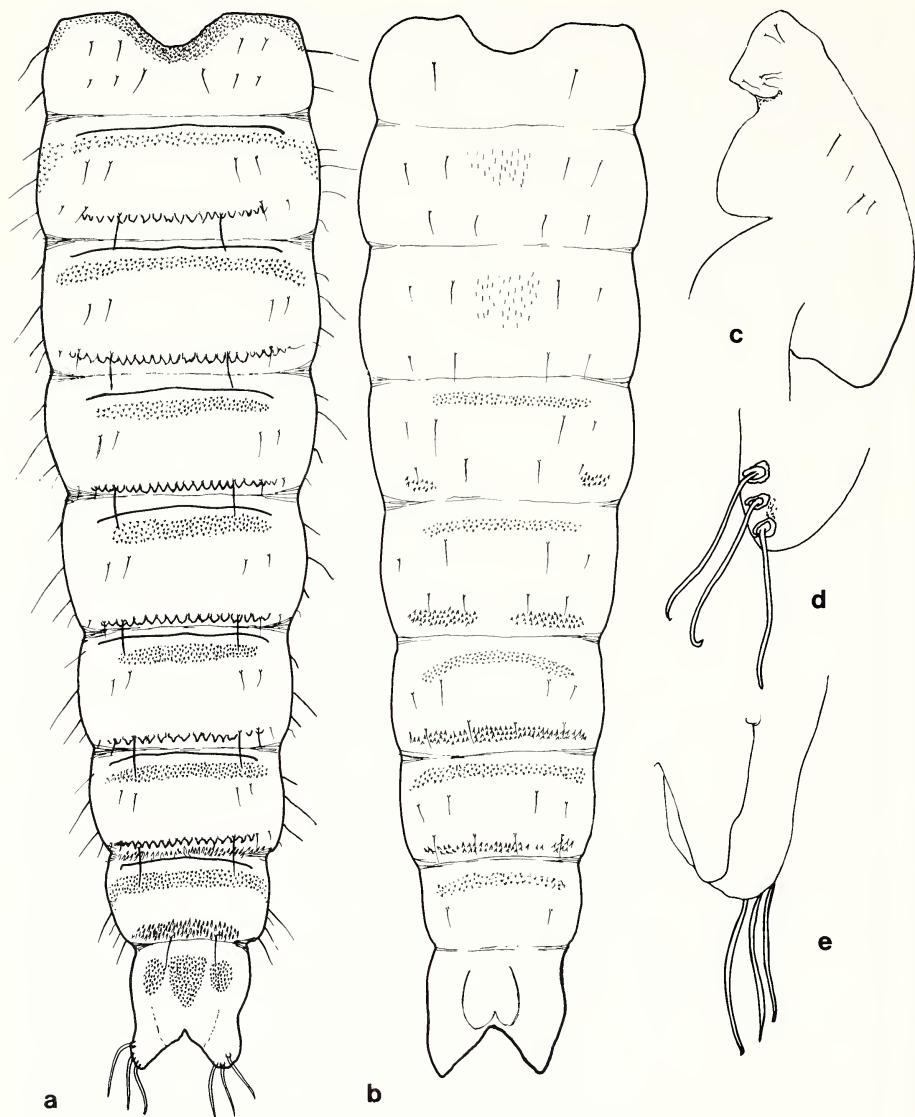


Fig. 3a-e. Pupa of *Metriocnemus yaquina*. a. Dorsal abdomen. b. Ventral abdomen. c. Lateral thorax. d. Anal macrosetae, ventral. e. Apex of anal lobe and genital sac of male, dorsal.

internally from margin of anal lobe. Macrosetae somewhat broadened and 0.43–0.50 length of segment IX. Genital sacs of both sexes do not over-reach anal lobe.

Fourth instar larva (N = 20) (Fig. 4). Body length 4.6–5.6 mm, colored dark blue-green dorsally, yellow-green ventrally, with head capsule 400–581, dark brown with black mentum and mandible. Antenna (Fig. 4a) four segmented, half mandible length,



Fig. 4a-f. Larva of *Metriocnemus yaquina*. a. Antenna. b. Labrum. c. Mentum. d. Mandible. e. Maxilla. f. Terminal abdominal segments.



segment lengths 51–65, 11–13, 5–7, 3–5. Antennal ratio 2.3–3.0. Antennal blade 25–31 long. Lauterborn organs and subsidiary style absent. Labrum (Fig. 4b) with SI setae and labral lamellae plumose, the labral lamellae curving dorsal to and between bases of SI. SIII setae simple and long, SII perhaps absent, SIV a single peg sensillum. Chaeta media finely plumose, remaining chaetae more coarsely branched apically; pecten epipharyngis of five subequal scales; three short apically divided chaetulae laterales; chaetulae basales narrow, one simple one apically finely divided. Premandible 77–81 long, with 2 subequal apical teeth and a strong brush. Mandible (Fig. 4d) 132–165 long, with short apical tooth and four inner teeth. Seta subdentalis 24–26 long, spine-like; seta interna with 6–7 serrate branches. Inner and outer margins of mandible smooth, without crenulations. Mentum (Fig. 4c) 106–134 wide, with two (uniquely three) median teeth and five pairs of laterals, with first laterals lower than the second. Maxilla (Fig. 4e). Squat, with lacinial chaetae undifferentiated, fine and simple. Sensilla basiconica well developed. Pecten galearis and appendix absent. Abdomen (Fig. 4f). Anterior parapod claws golden, simple, or on longer claws bearing a few subapical denticles. Posterior parapod 270–360 long, bearing simple yellow-brown claws. Anal tubules absent. Body setation very weak. Procercus yellow-brown 40–50 high by 30–45 wide, bearing 2 subequal lateral setae and 5–6 apical setae of maximum length 235–248. One apical procercal seta usually appreciably stronger (up to twice width of others), one moderate and 3–5 weak and shorter.

Third instar larvae (N = 15). As fourth instar except for the following measurements: Body length 2.7–4.1 mm, head capsule 265–320. Antennal lengths 26–33, 8–12, 6–7, 2–4; Antennal ratio 1.3–1.7. Mandible 85–105, mentum width 70–82. Procercus height 25–30, width 18–22, bearing two subequal apical setae of maximum length 188–210 and 3–5 short setae. Posterior parapod length 155–210.

*Holotype*. ♂ and associated exuviae, slide mounted in Euparal, UNITED STATES: Oregon, Franklin Co., nr Newport, Yaquina head, ex upper shore rock pool, 1.vii.1985, P. S. Cranston & D. D. Judd (AMNH).

*Paratypes*. 1♂ (BMNH), 8♀ all with associated exuviae; 2 unassociated exuviae, 3 pupae, 50 larvae, same locality and date as holotype (AMNH, BMNH, CNC).

*Etymology*. From the type-locality, Yaquina Head; to be treated as a noun in apposition.

*Comments*. This new species of *Metriocnemus* requires emendations to the generic diagnoses (larva: Cranston et al., 1983; pupa: Coffman et al., 1986). The clearly four segmented larval antenna differs from the 5 segments reported, although Picado (1913) clearly illustrated four segments for the larva of *M. abdominoflavatus* and one of the two larval species in *Lobelia brassicae* leaf axils (either *M. lobeliae* or *M. canus*, see below) has only four antennal segments. The lack of anal tubules has not been reported previously in the genus, but is not unexpected in a species from a habitat with highly conductive water, being found also in haline dwelling *Chironomus*, *Cricotopus* and *Halocladius* species.

The pupal anal macrosetae, at 0.45–0.5 as long as tergite IX, are relatively longer and also stouter than in any other *Metriocnemus* where finer setae 0.3 as long as tergite IX are the maximal development. Further unusual character states in the pupa are the relatively stout cephalothoracic setae and the strong development of anteriorly directed hooklets on tergal conjunctives VII/VIII and VIII/IX.

The reduction of the male antenna has not been reported previously in *Metriocne-*

*mus*. However, *Dolichoprymna longipennis* (Holmgren), with a reduced wing and male antenna, actually belongs in *Metriocnemus* (Saether, pers. comm.).

#### SYSTEMATICS

Saether (1977) placed *Metriocnemus* as sister group of *Thienemannia* Kieffer, and these forming the sister group of the remaining genera of the "Metriocnemini." Later Saether and Sublette (1983) suggested that *Metriocnemus* + *Thienemannia* was the sister group to genera based around *Pseudorthocladius*. Although *Metriocnemus* seems to be a well-founded monophyletic group based upon the pupal synapomorphy of the tergal posterior row of spine-like tubercles, the position of *Thienemannia* seems less well founded. In a recent study, Saether (1985) removed several problematic species from *Metriocnemus* to *Thienemannia* but further analysis is weakened by inadequate knowledge of many of the immature stages and many (if not all) differentiating character states in *Thienemannia* may be interpreted as plesiomorphies. The pupa of *M. yaquina* shows some intermediacy between *Metriocnemus* and *Thienemannia* in the relative length of the anal lobe setae, but the shape of the tergal spine-like tubercles are characteristic of *Metriocnemus*. Langton (1980) suggested that the two genera were not distinct; *M. yaquina* lends some support to this view, but we refrain from further comment until the immature stages of more *Thienemannia* are available.

Internal relationships within *Metriocnemus* are confused, with species groups erected on immature stages incongruent with those of adults. The male of *M. yaquina* shows a resemblance to *M. longipennis* and the *M. fuscipes* group through the reduced male antenna, absence of a virga, reduced (or absent) volsellae, but this placement is refuted by the immature stages of *yaquina* and only the male of *longipennis* is known (Saether, pers. comm.).

#### ECOLOGY OF *METRIOCNEMUS*

*Metriocnemus yaquina* is known only from rock pools within the splash zone of the Pacific Ocean on the Oregon coast. The pools were at or slightly above high tide level and were exposed to midday sun. By the first days of July a single pool only out of many in the zone retained any water, but even this liquid was of the consistency of thick green pea soup. Larvae were free-living in the rapidly diminishing pool and the previous presence of *Metriocnemus* larvae in similar but completely dry pools throughout the zone could be deduced from dried up larval remnants. Pupae were also free-living, with no evidence of the gelatinous pupal case observed in some congeners such as *M. knabi* Coquillett (Knab, 1905).

Morphometrics of the final instar larvae show an unexpectedly high variation in body, head capsule and mandible length within the final instar, less so in the third instar. In temporary habitats such as these rock pools, there will be advantages in an accelerated life history, with metamorphosis less dependent on body size. However, the reared adult females show less variability, but the sample size was smaller than for the 4th instar larvae and laboratory rearing may have disguised any effect.

Current knowledge of the world-wide distribution of *Metriocnemus* species depends upon a varied reassessment of the generic position of many species. A substantial number of species have been described in *Metriocnemus*, but many were allocated

to the genus on an outdated generic concept dependent solely upon adult male midges and encompassed most "hairy-winged" Orthocladiinae. However, although the genus needs further taxonomic revision, recent regional catalogues, both published and in press, have elucidated the basic distribution.

It is clear that there are at least twenty valid species in the northern hemisphere, of which about eight occur in both the Nearctic and Palearctic regions, including one that occurs as far north as 83°N at Lake Hazen, Ellesmere Island (Oliver, 1963). The number of described species, which may not reflect accurately the true diversity, increases southward from the Arctic to the temperate regions, then diminishes towards the tropics, with apparently few species occurring in the southern hemisphere. For example, in the Afrotropical region, of five described species, four occur at altitudes of over 2,000 m.

Larval *Metriocnemus* occur in one of the widest ranges of biotopes of any dipteran genus and perhaps are as catholic as any insect group. Within the wide geographic range indicated above, there are many stenotopic species, particularly those living in phytotelmata (plant-held water). We take the opportunity to review the literature and add several recent unpublished observations.

In the temperate Holarctic region, particularly in the northern part, several *Metriocnemus* species, including *fuscipes* Meigen, *terrester* Strenzke, *atratus* Zetterstedt and *ursinus* Holmgren have terrestrial larvae living in damp soils. *Metriocnemus* species can dominate some Holarctic boreal faunas. In Spitzbergen, *M. ursinus* was found to have a 3 year life cycle and production was estimated at around  $1 \text{ gm} \cdot \text{m}^{-1} \cdot \text{yr}^{-1}$  with highest densities occurring in *Deschampsia alpina*/moss tundra (Sendstad et al., 1977).

Some species of larval *Metriocnemus* exploit the hygropetric (=madicolous, thin water film) biotope. *M. hygropetricus* Kieffer, a well known species, grazes on natural rock face seepages as well as in trickle bed filtration-type sewage works (Lloyd et al., 1940) in the environs of which adult midges may occur in nuisance numbers (Learner, 1975; Cranston, 1984). *Metriocnemus* are not reported from a similar sewage works in North America (Usinger and Kellen, 1955). The species involved in British sewage beds, *M. hygropetricus* (Kieffer) (= *longitarsis* Goetghebuer) and *hirticollis* (Staeger), are also sympatric in commercial cultivations of watercress (*Rorippa nasturtium-aquaticum* Hayek (Brassicaceae)) in chalk spring-fed pools (Cranston, 1982). Larvae of both species were active above the water surface on the plant stems at night, retreating below the water as day temperatures rose and humidity dropped. Commercial cropping of the watercress took place at dawn, resulting in contamination of the crop with midge larvae (which consumers believed to be "flukes"). There is close similarity between *hygropetricus* and *hirticollis* in morphology, behaviour, and ecology where the species appear always to be sympatric in the hygropetric zones, seepages and first order streams. The larvae are separable only by the purple banding of *hygropetricus* in contrast to the green *hirticollis*, while the adults differ only in the depth of pigment of the haltere, a character which appears to vary with adult age (K. Goldie-Smith, pers. comm.). It is possible, but not yet established, that these may be colour polymorphs of a single species.

Several temperate to subtropical species are specialist dwellers in phytotelmata and some have been relatively well studied. *Metriocnemus martinii* Thienemann



(=*cavicola* Kieffer) larvae appear restricted to tree-holes, particularly in beech (*Fagus sylvaticus* L.) in middle latitudes in Europe. Kitching (1971) observed up to 3 generations per year in southern England, but age structure analysis was difficult because the species was highly variable and several tree holes lacked overwintering larvae (Kitching, 1972). Although the fauna has been investigated in Indonesia, Australia and the Nearctic, tree-hole *Metriocnemus* may be restricted to the western Palaearctic region. Our examination of north Nearctic tree holes showed no larval Chironomidae. Predatory *Toxorhynchites* (Culicidae) larvae in Nearctic tree holes might deter *Metriocnemus* but even in the absence of *Toxorhynchites* in Michigan *Metriocnemus* larvae have not been found (R. W. Merritt, pers. comm.). In California, *Polypedilum* and *Limnophyes* occur in seasonally flooded tree holes but *Metriocnemus* were not found (Grodhaus and Rotramel, 1980).

In temperate North America, the principal phytotelmata occupied by *Metriocnemus* species are pitcher plants of the family Sarraceniaceae. Larval *M. knabi* occur in many *Sarracenia purpurea* L. leaf axils, usually in the company of the mosquito *Wyeomyia smithii* (Coquillett). *Sarracenia*, which grow on bogs throughout eastern USA, as far north as New Brunswick (Canada), attract and trap insect prey. These are the basis of a food chain within the plant, in which larval *M. knabi* live in or just above the decaying insect remains where they are decomposers that enhance prey breakdown and nutrient uptake to the plant (Bradshaw and Creelman, 1984). *M. knabi* are not found outside *Sarracenia* leaf axils, but larvae continue development through to successful eclosion in insect debris held in distilled water outside the pitcher. Despite the high respiration rate of the accumulated decaying insect remains, Cameron et al. (1977) found the oxygen level in pitchers dropped on lower than 77% saturation and it is clear that *M. knabi* is not the euryoxybiont that might have been supposed. There appears to be a single protracted adult emergence period in bogs in south-western Québec (Canada) (Cranston, pers. obs.) while in southern New Brunswick a May emergence was followed by a summer larval cohort resulting in fall emergence (Paterson and Cameron, 1982). The situation is not clear in southern USA populations. Larval mortality during the winter freeze-up of *Sarracenia* axillary contents may be negligible (Paterson, 1971) or as high as 33% (Swales, 1972). In California and southern Oregon *Darlingtonia californica* Tilley (Sarraceniaceae) occur in place of *Sarracenia* and the inquiline *Metriocnemus edwardsi* Jones replaces *M. knabi* (Jones, 1916) probably also acting as a detritivore on decaying insects (Szerlip, 1975). Much less is known concerning the ecology of this relationship than that of *Sarracenia* and *M. knabi*, probably reflecting the scarcity of the host plant.

In the Old World, notably South-east Asia, Sri Lanka and Madagascar, pitcher plants belong to the family Nepenthaceae, unrelated to the Nearctic Sarraceniaceae. There are between 65 and 70 species in the solitary genus *Nepenthes* L. with 28 species on the island of Borneo (Steenis and Balgooy, 1966). *Nepenthes* pitchers can contain a diverse aquatic fauna, dominated by Diptera, particularly Culicidae (Beaver, 1979, 1980). Neither Thienemann (1932), Erber (1979) nor Beaver (*loc. cit.*) reported Chironomidae amongst the extensive invertebrate community of pitchers (n.b. early records of Chironomidae in fact refer to Ceratopogonidae, principally *Dasyhelea* spp.). However, in 1976 Cranston found larvae of *Metriocnemus* and *Polypedilum* in a *Nepenthes* (probably *villosa* Hook) pitcher from 2,700 m altitude



at Carson's Camp on Mount Kinabalu (Sabah = North Borneo). This observation constitutes the unpublished record quoted in Beaver (1983:156). In 1982, very similar species of larval *Metriocnemus* and *Polypedilum* were discovered in imported *Nepenthes villosa* intercepted on arrival in Britain from Sabah. A third record of *Metriocnemus* from *Nepenthes* concerns larvae from *N. tentaculata* Hook at 2,200 m on Mount Kinabalu (collected iv. 1984, Ilia Barker). In no case were the larvae successfully reared, although they lived in decaying insect-enhanced distilled water for several weeks before dying.

Throughout the world, there are a wide variety of "tank-plants" in addition to pitchers. In tropical America many bromeliads (Bromeliaceae) retain substantial quantities of water in leaf axils. A substantial aquatic fauna may develop in the larger and longer-lived tanks. Picado (1913) described *Metriocnemus abdominoflavatus* from Costa Rican bromeliads, together with other insects including a genus *Chirocladius* which is clearly a *Polypedilum*. In the Virgin Islands *Metriocnemus* found in many of the *Tillandsia* L. and *Aechmea* Ruiz & Pavon (Bromeliaceae) axils sampled, with *Polypedilum* and a tanypod occurring more widely. In Jamaican bromeliads only "*Chironomus*" and "*Pentaneura*" (Tanypodinae) were found (Laessle, 1961).

Many water-holding plants occur in both the wet and dry tropics, although relatively few have been investigated in any detail. Thienemann's major study of phytotelmata in Indonesia (Thienemann, 1934) revealed chironomid faunas in *Colocasia* Schott, *Pandanus* L. fil and bamboo (*Bambusa* Schreber) but these did not include *Metriocnemus*. However, in the Afrotropical region *M. wittei* Freeman was reared from the axils of wild bananas at 8,000 ft at Musandama in Uganda and *M. lobeliae* Freeman from larvae found in leaf axils of *Lobelia sattimae* R. E. Fries & T. C. E. Fries growing at 12,000 ft on Mt. Kinagop in the Kenyan Aberdare Range (Freeman, 1956). At a similar altitude of between 12,000 and 13,000 ft on Mount Kenya two species of larval *Metriocnemus* appear to coexist in the mucilaginous liquid contained in the leaf axils of *Senecio brassica* R. E. Fries (Cranston, pers. obs.). Neither species could be reared, but a pharate male of *M. canus* Freeman was present in its mucilage tube just at the water level in the axil—a species previously known only as adults from high altitudes in the Kenyan Aberdare Mountains, the Ugandan and Zairean Ruwenzori Mountains. The second species is likely to be *M. lobeliae*. On Mount Kenya larvae survived night temperatures of  $-12^{\circ}\text{C}$  that led to freezing of the axillary liquid alternating with high day-time temperatures.

In temperate Europe there are water-holding plants with *Metriocnemus* faunas in addition to the tree-holes discussed above. Zavřel (1941) named a variety *dipsaci* of *M. hirticollis* for a population living in the axils of teasel (*Dipsacus fullonum* L.). In the Soviet Union, Borob'ev (1960) found unidentified *Metriocnemus* larvae in axils of teasels growing in forested areas. Recently, Baumgartner (1986) discovered larvae of *M. nr knabi* abundant in teasels growing in Illinois, USA. Strenzke's (1950) survey in Germany of Wood Club-rush (*Scirpus silvaticus* L. (Cyperaceae)) revealed two species of *Metriocnemus* living in the leaf axils—*M. scirpi* Kieffer and *M. inopinatus* Strenzke. These species have not been rediscovered since the original description, but appear to be restricted to *Scirpus* phytotelmata.

Thus, although rock pools have not been previously cited as a habitat for *Metriocnemus*, species live in such a wide variety of small water bodies that it is not unexpected for *M. yaquina* to occur in such a habitat.

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**BIOLOGY AND MATURE LARVA OF  
*HEMIPIMPLA PULCHRIENNIS* (SAUSSURE), A PARASITE OF  
*ROPALIDIA* (HYMENOPTERA: ICHNEUMONIDAE, VESPIDAE)**

ROBERT W. BROOKS AND DAVID B. WAHL

Snow Entomological Museum, Snow Hall, University of Kansas,  
Lawrence, Kansas 66045-2106, and  
American Entomological Institute, 3005 SW 56th Ave.,  
Gainesville, Florida 32608

*Abstract.*—The biology and mature larva of *Hemipimpla pulchripennis* (Saussure), are described for the first time. The relationships among the tribes of Pimplinae are discussed with emphasis on the Ephialtini, of which *Hemipimpla* is a member.

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*Hemipimpla* is an Old World tropical genus belonging to the Pimplinae, a large and widely distributed subfamily of usually ectoparasitic ichneumonids. Treated as a subgenus of *Camptotypus* by Townes (1969), it was raised to generic status by Gupta and Tikar (1976). Members of its tribe, the Ephialtini, are recorded as ectoparasitoids mostly of concealed Lepidoptera larva, although some attack spider egg sacs or adults, aculeate Hymenoptera larvae in nests in wood, or Coleoptera larvae. No larvae and only scattered host records are known for *Hemipimpla* and the related genera (*Camptotypus*, *Zonopimpla*, *Odontopimpla*, *Cenodontis*, *Parvipimpla*, and *Clydonium*) that make up the *Camptotypus* Group (Gauld, 1984; Townes and Townes, 1960). The recent rearing of *Hemipimpla pulchripennis* (Saussure) from a nest of *Ropalidia formosa* (Saussure) [Vespidae: Polybiinae] is the second time a species of *Hemipimpla* has been reared from a social vespid and allows its larval morphology to be described for the first time.

A source of potential confusion for the reader is the unsettled situation regarding tribal nomenclature in the Pimplinae. Without going into an extensive discussion, the nomenclature of Gauld (1984) is used herein. His Ephialtini is the equivalent of the Pimplini of Townes (1969), Short (1978), and Carlson (1979). The Ephialtini of Finlayson (1967a) includes tribes kept separate by the above authors (Delomeristini, Neoxoridini, Polysphinctini, and Rhyssini). Pimplini *sensu* Gauld is the equivalent of the Ephialtini of Townes (1969), Short (1978) and the Ecthromorphini of Carlson (1979).

Voucher specimens of *R. formosa* and *H. pulchripennis* are deposited in the Snow Entomological Museum, University of Kansas, Lawrence, Kansas. The biology section was written by R. W. Brooks and the larval description by D. B. Wahl.

**BIOLOGY**

On 7 November 1984, three active (nos. 2, 3, 5; Fig. 1) and two inactive (nos. 1, 4) nests of *Ropalidia formosa* were collected under the eave of a window of a storage building in the Parc de Tsimbazaza, Antananarivo, Madagascar. Each nest had a single female. Nests were put into sealed boxes and checked at irregular intervals.



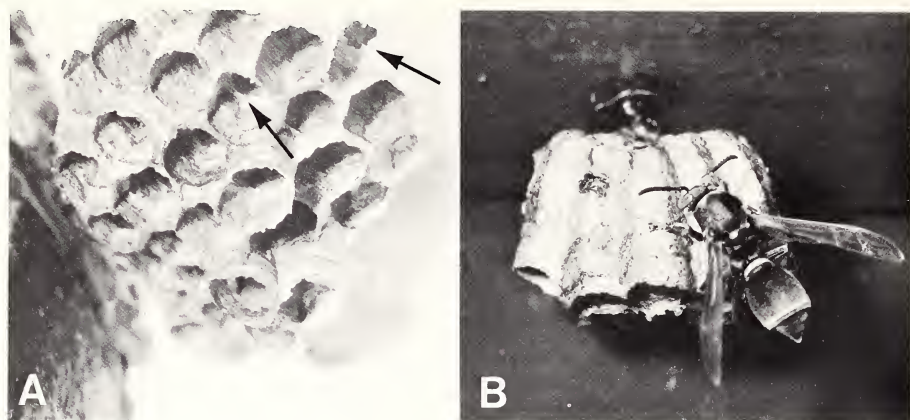


Fig. 1. Nests of *Ropalidia formosa*. A. Nest no. 3 with arrows showing remnant of silken cap spun by *Hemipimpla pulchripennis*. B. *R. formosa* foundress sitting on nest no. 2.

The three nests of *R. formosa* were 2–2.5 cm wide and about 1.5 cm high (Fig. 1). Figure 2 illustrates the condition of each cell. Nest no. 2 had seven cells, two of which were just initiated (3–4 mm high) and the others sealed. On each day, 8 and 9 November, a female *H. pulchripennis* emerged. Sometime during January 1985, a male of the same species was found. Examination of the last two sealed cells showed a dead host adult and a female *H. pulchripennis*. Altogether, four ichneumonids and one host emerged from nest no. 2. Nest no. 3 had 11 cells with host eggs: two cells had a single egg, five cells had two eggs each, and four cells had three eggs each. Two cells were empty and something had apparently emerged from them. Three cells were sealed. From one of the latter, a female *H. pulchripennis* emerged sometime in January 1985. Three of the cells in the nest showed white silken caps (Fig. 1A, arrows) similar to those shown by Keeping and Crewe (1983) and those made by other ichneumonid species. When a host cap is present on a parasitized cell, the ichneumonid silk cap is visible underneath upon dissection.

Adults of *H. pulchripennis* were fairly common diurnally and over a two week period in October four were seen flying about shrubbery in the shade. About two dozen specimens were trapped in four malaise traps in the Parc de Tsimbazaza.

Keeping and Crewe (1983), from 62 colonies of *Belonogaster juncea colonialis* Kohl and *B. petiolata* (De Geer) in the Transvaal, found three nests parasitized with *Hemipimpla apicalis* (Brulle) and two nests with *Anacamptomyia* sp. (Diptera: Tachinidae). They found *H. apicalis* to be an early season parasite and *Anacamptomyia* to parasitize late in the season. Richards (1969) and Crosskey (1981) have also reported *Anacamptomyia* attacking colonies of *Ropalidia*. From my small sample I have also found *H. pulchripennis* to be an early season (October) parasite and an undescribed species of *Anacamptomyia* (N. E. Woodley, pers. comm.) to be a late season (February) parasite. The latter record is from a nest collected by J. Wenzel. In agreement with Keeping and Crewe, I found *H. pulchripennis* to be either a prepupal or pupal parasite as evidenced by the cell height and remnants of the host pupal cocoons. Only one adult *H. pulchripennis* emerged from each host cell since

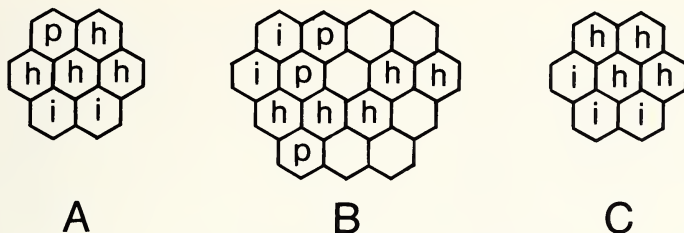


Fig. 2. Contents of nests of *Ropalidia formosa*. A. nest no. 2. B. Nest no. 3. C. Nest no. 5. p = remnant of white silken cap of *Hemipimpla pulchripennis*; h = host pupal silk evident; i = partially completed cell with host egg or eggs.

one ichneumonid head capsule was found per cell. All parasitized cells were close to the nest pedicel, that is, they were the first or nearly the first cell constructed.

Except for the host records of Keeping and Crewe (1983), previously reported hosts of *Hemipimpla* and the closely related *Camptotypus* are Lepidoptera. Seyrig (1932) reared an undetermined Malagasy *Hemipimpla* from an unknown species of pyralid. This species of *Hemipimpla* was a pupal parasite and fed rapidly on a rather darkened and decayed host. From eclosion of the ichneumonid egg to cessation of feeding was less than five days. The mature larva then spun a cocoon inside the cocoon of the caterpillar and emerged as an adult 16 days later. *H. pulcher* has been reared from a drepanid, *Epicampoptera andersoni* (Tams) (Townes and Townes, 1973). *Camptotypus arianus* (Cameron) was reared from the Indian Teak Moth, *Hyblaea pueria* Cramer [Hyblaeidae] (Gupta and Tikar, 1976). Another genus in the *Camptotypus* group of genera, a species of *Claydonium*, has been reared from *Pseudomopsis peckolti* (Costa-Lima) [Curculionidae] (Townes and Townes, 1966).

#### MATURE LARVA OF *HEMIPIMPLA PULCHRIPENNIS*

Figure 3 illustrates the cephalic sclerite and an anterior spiracle of the mature larva of *Hemipimpla pulchripennis*; the specimen was reared from *Ropalidia formosa* (nest no. 3) collected in Antananarivo, Madagascar, 7 November 1984, by R. W. Brooks. Methods of preparation are those given in Wahl (1984). The terminology of the cephalic sclerites is that of Finlayson (1975) and Short (1978) except that *length of mandible* is here used for "full width of mandible."

**Description.** Cephalic sclerites strongly to moderately sclerotized. Epistoma incomplete medially. Pleurostoma broad. Hypostoma laterally expanded for almost entire length, its margins irregular in outline; hypostomal spur about  $1.9\times$  as long as basal width, meeting stipital spur at its medial tip. Stipital sclerite reduced, about  $0.4\times$  as long as hypostoma. Labral sclerite present. Labial sclerite roughly triangular in shape, lateral arms fused dorsally; ventral margin without lobes. Silk press in form of transverse slit. Prelabial sclerite absent. Maxillary and labial palpi each bearing one oval and one crescentic sensillum. Mandibular base large; blade about  $0.5\times$  as long as mandible, upper and lower edges with fine teeth. Antenna papilliform. Spiracle with closing apparatus adjacent to atrium; atrium goblet-shaped with large opening. Skin with numerous small round protuberances and widely scattered small setae.

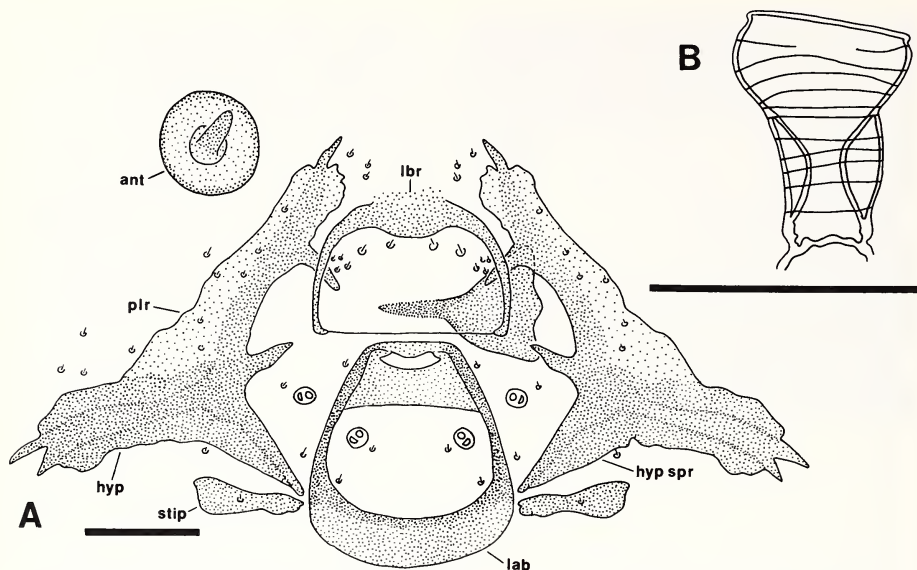


Fig. 3. Mature larva of *Hemipimpla pulchripennis*. A. Cephalic sclerites. B. Spiracle [ant = antenna, lab = labial sclerite, lbr = labral sclerite, hyp = hypostoma, hyp spr = hypostomal spur, plr = pleurostoma, stip = stipital sclerite]. Scale bars = 0.1 mm.

The parasitoid's larval remains were found within the host cell. A white silk cap near the anterior end of the cell was the only indication of any cocoon-spinning activity.

**Discussion.** In the following section, hypotheses of character polarity were determined by outgroup comparison. The Pimplinae are apparently the sister-group of an unnamed lineage consisting of the Acaenitinae, Oxytorinae, Diplazontinae, and Orthocentrinae (Wahl, 1986, and unpubl. data). As there is no general phylogeny for ichneumonids, further outgroup comparison consisted of a survey of the family.

Of the thirty-one genera presently included in the Ephialtini, the mature larva is known for only thirteen (Short, 1978), primarily from the Nearctic or western Palearctic. The larva of *Hemipimpla* is remarkable among ephialtines for the relatively wide pleurostoma and the extensive lateral expansion of the hypostoma (present for almost the entire length of the structure). Ephialtines other than *Hemipimpla* usually have any lateral hypostomal expansion restricted to a smaller portion of the hypostoma and almost never exhibit the irregular margins found in this species.

The relationships among the seven currently recognized tribes of the Pimplinae (Ephialtini, Polysphinctini, Pimplini, Delomeristini, Diacritini, Neoxoridini, and Rhyssini—Gauld, 1984) are unclear. Finlayson (1967a) separated the subfamily into two tribes, the Pimplini and Ephialtini, on the basis of larval characters. Her Ephialtini (containing all the taxa treated as tribes by Townes except for the Pimplini) is unnatural since, in retrospect, it is defined by plesiomorphic characters. While the Diacritini, Neoxoridini, Pimplini, Polysphinctini and Rhyssini appear to be monophyletic groups on the basis of adult and/or larval characters (larvae of Diacritini are unknown), their relationships to one another and to the Delomeristini and Ephial-



tini are uncertain. Gauld (1984) states that the Delomeristini are probably paraphyletic. The delomeristines for which the larvae are known share a striking character with the Rhyssini: a large tooth-like projection at the mandibular base. It should be noted that the projection in *Delomerista diprionis* Cushman (Short, 1978) and *novita* Cresson (Finlayson, 1967b; Short, 1978) does not resemble the character found in *D. japonica* Cushman and the remaining delomeristines and rhyssines. Various projections are found at the mandibular bases in pimelines as well, but by their appearance and location do not seem to be homologous with those of the above two tribes. Townes and Townes (1960) pointed out that the Polysphinctini is a specialized off-shoot of the Ephialtini, thus rendering ephialtines paraphyletic; they may be so with respect to other tribes as well, according to Gauld (1984). The synapomorphy of a hypostoma with some degree of lateral expansion, however, appears to delimit a group within the Ephialtini, one that consists of *Hemipimpla* and six other genera (*Acropimpla*, *Gregopimpla*, *Iseropus*, *Scambus*, *Sericopimpla*, and *Zaglyptus*). A number of these genera share adult and larval synapomorphies with polysphinctines (Short, 1978; Townes and Townes, 1960), including a laterally expanded hypostoma in most polysphinctines.

*Hemipimpla*'s dorsal fusion of the lateral arms of the labial sclerite is also present, in at least some species of ephialtine genera. This character, although derived, is apparently present in some Rhyssini and Delomeristini. The phylogenetic significance of the character must await further analysis. *Hemipimpla* is, so far as known, unique for the expanded juncture between the lateral arms of the labial sclerite.

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**SYSTEMATICS OF PSEUDOCLOEON, ACENTRELLA,  
BAETIELLA, AND LIEBEBIELLA, NEW GENUS  
(EPHEMEROPTERA: BAETIDAE)**

R. D. WALTZ<sup>1</sup> AND W. P. McCAFFERTY

Department of Entomology, Purdue University, West Lafayette, Indiana 47907

**Abstract.**—Detailed character analysis has allowed a more natural classification in the Baetidae as follows. *Pseudocloeon* Klapálek must presently be restricted to the type species, *P. kraepelini* Klapálek, a species known only from adults. Certain *Pseudocloeon* species are placed in the genera treated here. *Liebebiella*, new genus, includes: *L. orientale* (Müller-Liebenau), new combination (type species); *L. ambigua* (Müller-Liebenau), new combination; *L. atoki* (Müller-Liebenau), new combination; *Liebebiella deigma*, n. sp.; *L. difficila* (Müller-Liebenau); *L. klapaleki* (Müller-Liebenau), new combination; *L. proxima* (Müller-Liebenau), new combination; *L. siveci* (Braasch), new combination; and *L. vera* (Müller-Liebenau), new combination. *Acentrella* Bengtsson is revised to include: *A. lapponica* Bengtsson (type species); *A. ampla* Traver; *A. carolina* (Banks), new combination; *A. chantauensis* (Kluge), new combination; *A. fenestrata* (Kazlauskas), new combination; *A. gnom* (Kluge), new combination (= *Pseudocloeon ultimum* Müller-Liebenau, new synonymy); *A. insignificans* (McDunnough), new combination; *A. lata* (Müller-Liebenau), new combination; *A. sibirica* (Kazlauskas), new combination; *A. sinaica* Bogoescu; *A. tonneri* (Braasch and Soldán), new combination; and *A. turbida* (McDunnough), new combination. *Baetiella* Ueno (= *Neobaetiella* Müller-Liebenau, new synonymy) is revised and includes: *B. japonica* (Imanishi) (type species); *B. aino* (Matsumura), new combination; *B. armata* Braasch; *B. ausobskyi* Braasch; *B. bispinosa* (Gose), new combination (= *Neobaetiella macani* Müller-Liebenau, new synonymy); *B. imanishii* Braasch; *B. innotata* (Braasch), new combination; *B. ladakae* Traver; *B. marginata* Braasch; *B. muchei* (Braasch), new combination; *B. tuberculata* (Kazlauskas), new combination; and *B. ursina* (Kazlauskas), new combination. *Neobaetiella imanishi* Müller-Liebenau is a nomen nudum, and *Neobaetiella uenoi* Müller-Liebenau is an unavailable name.

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Baetid mayflies classified in the genera *Acentrella* Bengtsson, *Baetiella* Ueno, *Barbaetis* Waltz and McCafferty, *Heterocloeon* McDunnough, *Platybaetis* Müller-Liebenau, as well as most Holarctic *Baetis* Leach (Waltz and McCafferty, 1987a) and *Pseudocloeon* Klapálek sensu auctt. are distinguished from the larvae of all other baetids by their synapomorphic possession of a ventral femoral patch (Figs. 1, 4, 5, 12, 17). Within this grouping, which we call the *Baetis* complex of genera, generic classification has been dubious and polyphyletic, at least in part, because of the historical use of phylogenetically unreliable adult characters as *prima facie* generic criteria. In particular, the number of forewing marginal intercalaries and the relative size and venational characters of the hindwings have been emphasized. Our extensive morphological study of the *Baetis* complex of genera indicates that such wing characters do not necessarily reflect phyletic relationships. The reduction of the hindwing and its venation, although apomorphic, cannot be used alone for deciphering generic relationships because they are highly subject to parallel evolution and often accompany the widespread and independent reductionistic tendencies found among many different lineages of baetids.

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<sup>1</sup> Current address: Thames Science Center, Gallows Lane, New London, Connecticut 06320.

Recent studies of *Baetis*, e.g., Müller-Liebenau (1970, 1973a) and Morihara and McCafferty (1979a, b), have elucidated numerous larval characters of systematic use for *Baetis* species that are also generally applicable to other genera of the *Baetis* complex but not to all Baetidae. Species-level systematics of Baetidae is now primarily based on larval morphology (Müller-Liebenau, 1981; Müller-Liebenau and Hubbard, 1986) but, to a large degree, generic limits have remained adult oriented. Our incorporation of cladistically informative larval characterization for defining generic limits has led to the revisionary systematics of the *Baetis* complex genera *Pseudocloeon*, *Acentrella*, and *Baetiella*, and the description of a new genus.

Institutions and individuals that loaned material for this study and the acronyms by which they are cited are B. Kondratieff (BK), Cornell University (CU), Harvard Museum of Comparative Zoology (MCZ), Oregon State University (OrSU), Purdue Entomological Research Collection (PERC), Stroud Water Research Center (SWRC), National Museum of Natural History, Washington, D.C. (USNM), University of Utah (UU), Virginia Polytechnic Institute and State University (VPI), and the Zoologisches Staatsmuseum, Munich (ZSM).

#### *Pseudocloeon* Klapálek, 1905

*Description.* Larva. Unknown. Adult. The adult was recently redescribed by Waltz and McCafferty (1985a).

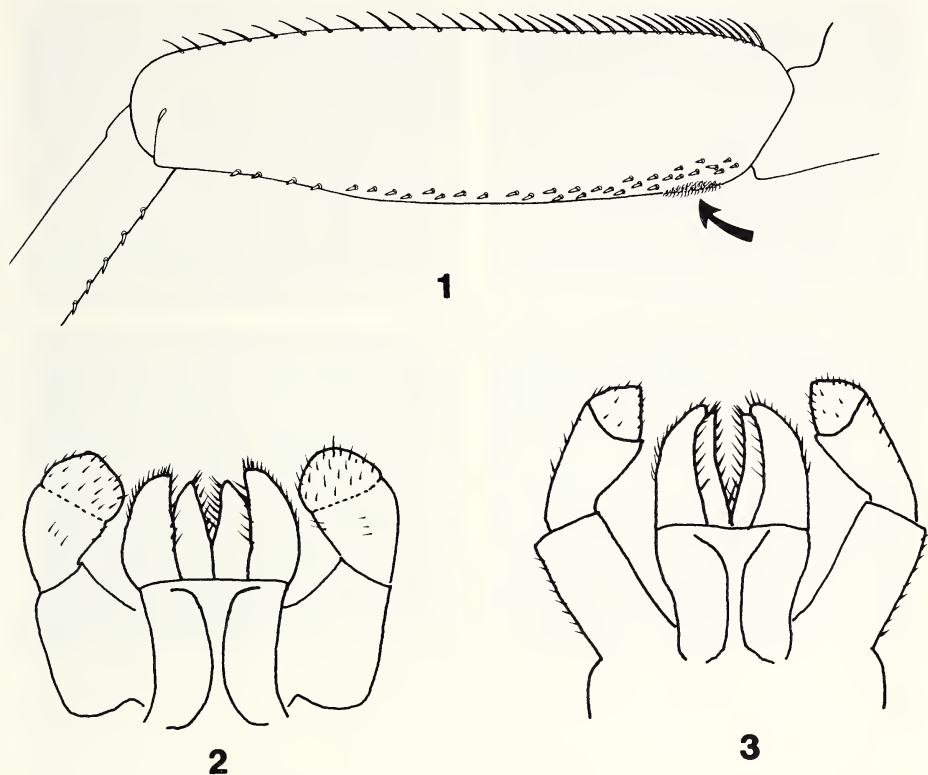
*Type species.* *Pseudocloeon kraepelini* Klapálek 1905:105, by monotypy.

*Material examined.* Lectotype, male imago, Java, Buitenzorg, 24.ii. to 12.iii.1904, leg. P. Kraepelin, des. Waltz and McCafferty, 1985. Paralectotypes, 2 male imagos and 1 subimago, same data as lectotype, des. Waltz and McCafferty, 1985.

*Distribution.* Java.

*Remarks.* The only *bona fide* material of the genus *Pseudocloeon* is represented by the type series of four adult specimens deposited at the University of Hamburg. Other adult Baetidae that have been classified as species of *Pseudocloeon* are considered provisionally placed (Müller-Liebenau, 1981) because the genus has been historically characterized solely by the combined characters of paired intercalaries along the forewing margin and the absence of hindwings. Since hindwings have been lost numerous times in many independent lineages of Baetidae (Edmunds et al., 1976; Gillies, 1979; Müller-Liebenau, 1978, 1980, 1981, 1984a; Waltz and McCafferty, 1985b, c, 1986, 1987b, c, d), it follows that not only is there a strong possibility that the group of species presently assigned to *Pseudocloeon* are polyphyletic, but that the type species itself is congeneric with another genus. For example, our review of the type species, *P. kraepelini* (Waltz and McCafferty, 1985a), suggests a close, if not congeneric relationship with some *Baetis* species known in the *Baetis atrebatinus* complex (Müller-Liebenau, 1981, 1984a).

The doubt surrounding the integrity of *Pseudocloeon* would be soluble if the larval stage (the stage necessary for addressing phyletic affinities and taxonomic delimitation in the family Baetidae) of the type species of *Pseudocloeon* were known. Such is not the case and any larvae of species now assigned to *Pseudocloeon* are no more reliably representative of the type species of *Pseudocloeon* than are their associated adults. As the larval stages of the presumed species of *Pseudocloeon* have become known in detail, these species have generally been reclassified into genera with the appropriate

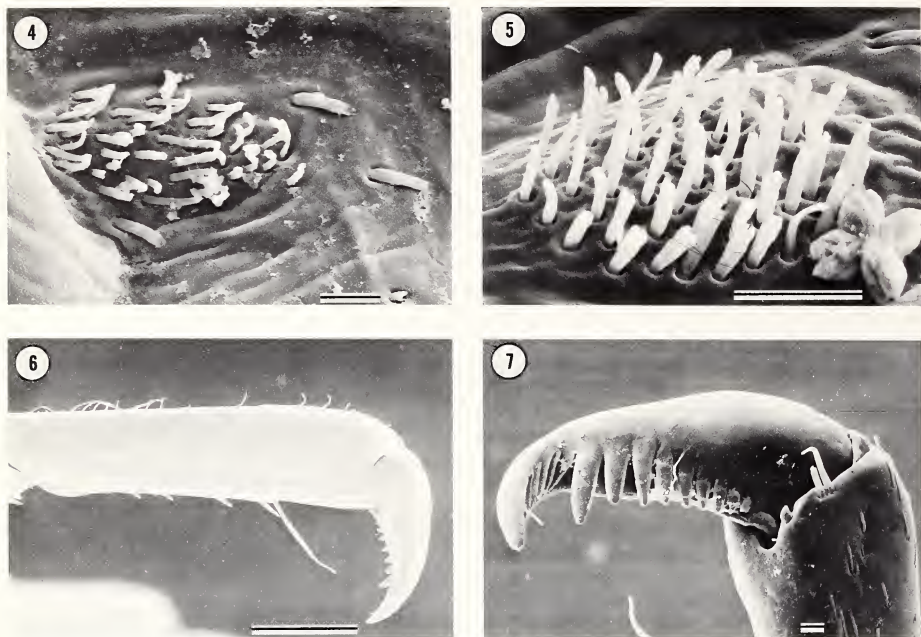


Figs. 1-3. 1. *Acentrella ampla* foreleg showing ventral patch. 2. *Acentrella lapponica* larval labium. 3. *Baetiella japonica* larval labium.

larval affinities (Edmunds, 1974; Edmunds et al., 1976; Müller-Liebenau, 1981; Waltz and McCafferty, 1985b, 1986, 1987b, c). We do not, however, agree with the indiscriminate move of all present *Pseudocloeon* into *Baetis* as per Keffermüller (1980) because there are in fact many included species that will require reassignment to genera other than *Baetis*.

Based on the above we propose that *Pseudocloeon* be restricted at this time to include only the type species from Java, *P. kraepelini*, although we are cognizant that many species will remain by default in *Pseudocloeon* until their larval stages are known and they can be correctly placed to genus. This taxonomic move essentially allows workers to proceed with the necessary revision of the Baetidae without relying on only presumptive concepts of *Pseudocloeon* and also precludes the further proliferation of a nomenclature that most probably would have to be revised at a later date. In keeping with this, we herein transfer many of the Oriental species previously placed in *Pseudocloeon* (Müller-Liebenau, 1981, 1982a, b, 1984b, 1985; Braasch, 1983) to the following new genus in addition to revising the genera *Acentrella* and *Baetiella* to include numerous species previously placed in *Pseudocloeon*.





Figs. 4-7. *Liebebiella* spp. larvae. 4. *L. orientale*, ventral femoral patch. 5. *L. vera*, ventral femoral patch. 6. *L. orientale*, tarsus and claw. 7. *L. orientale*, claw. (Scale: Figs. 4, 5, 7—bar = 10  $\mu$ m; Fig. 6—bar = 100  $\mu$ m)

### *Liebebiella*, new genus

*Description.* Larva. Antennae ca.  $1.5 \times$  length of head capsule. Mandibular incisors fused (Müller-Liebenau 1982b: figs. 1f, 2d, 3e, 4d, 5d). Maxillary palp two segmented (*ibid.*: figs. 1c, 2c, 3d, 4c, 5c). Labium (*ibid.*: figs. 1b, 2b, 3b, 4b, 5b) with palps shortened (as in Fig. 2); segment 2 of palp with weakly developed inner lobe; segment 3 of palp rounded, weakly tapered, or flattened apically.

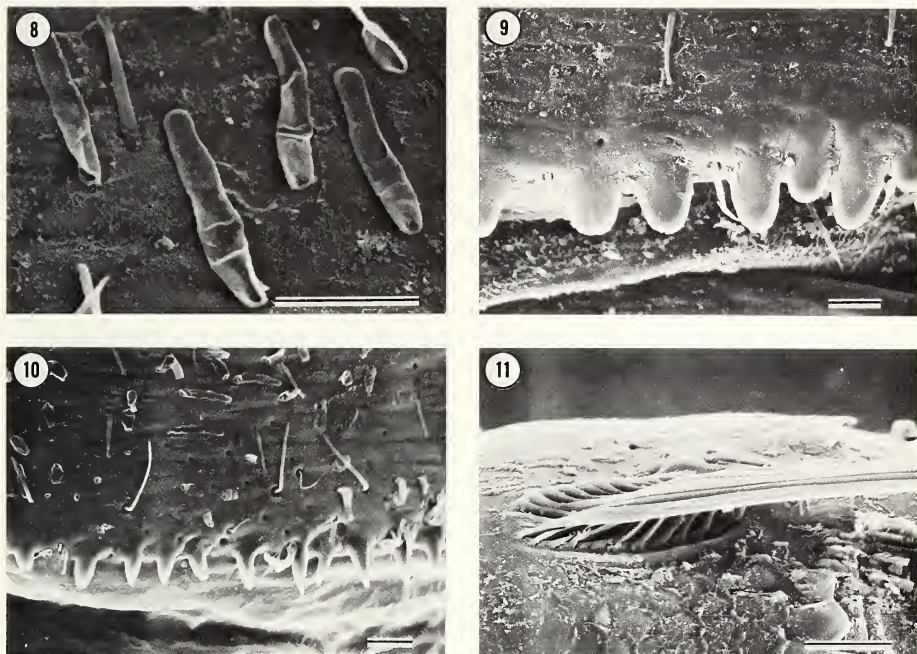
Prothorax with distinctive *lapponica*-type color pattern (*ibid.*: figs. 7, 9, 11) or without such pattern. Femora of all legs with long, multilaterally ciliate bristles (the ciliae are relatively long and dense) (Müller-Liebenau, 1981: fig. 4i); ventral femoral patch present (Figs. 1, 4, 5). Metatibia with one or two (*ibid.*: fig. 4i) rows of long ciliate bristles. Tarsus (Fig. 6) of all legs with long, ventral subapical bristle. Claws (Fig. 7) with one row of denticles and one pair of long subapical bristles.

Abdomen without dorsal tubercles; not dorsoventrally flattened. Tergal scales absent, median row of long, hyaline bristles present dorsally; tube scales (Fig. 8) present or absent. Posterior marginal spines (Figs. 9, 10; Müller-Liebenau, 1982b: figs. 8, 10, 12, 13, 14) distinct and entire. Gills simple and without serrate margins. Cerci without (only in the species *L. atoki*) or with (Fig. 11) lateral bristles along interior margin.

Adult. Unknown.

*Type species.* *Pseudocloeon orientale* Müller-Liebenau, 1982b:289.

*Material examined.* *Pseudocloeon difficilum* Müller-Liebenau, 3 larvae, FC30/b, 10.xii.1970, We-ganga in Balangopa (Belihuluya), leg. Starmölner, det. Müller-Lie-



Figs. 8–11. *Liebebiella* spp. larvae. 8. *L. vera*, tube scales of abdominal terga. 9. *L. orientale*, tergal posterior margin. 10. *L. vera*, tergal posterior margin. 11. *L. orientale*, cerci. (Scale: Figs. 8–11—bar = 10  $\mu$ m)

benau (ZSM). *Pseudocloeon orientale* Müller-Liebenau, 3 larvae, FC23/b, 3.xii.1970, Dickoya River, Maskeliya, leg. Starmülner, det. Müller-Liebenau (ZSM). *Pseudocloeon verum* Müller-Liebenau, 2 larvae, Malaysia, Tributary of the River Gombak, 21 miles N of Uciala Lumpur on Bentong Road, 23.viii.1969, leg. J. E. Bishop, det. Müller-Liebenau (ZSM). *Pseudocloeon* sp. 1 Ulmer, 6 larvae; 5 larvae, FM 7, Tjurup, Musi in Ajer Simpang, 6.v.1929, 1 larva slidemounted (Müller-Liebenau) in euparal(?) and 3 larvae (missing head capsules) in alcohol and 1 male larva with mouthparts, legs, forewing of subimago (extracted from larval wingpads), slidemounted (Müller-Liebenau) in euparal(?), remainder of body in alcohol; 1 male larva, South Sumatra, FM8b, Musi-Gebeit, warm spring Subang Ajam on the Kali Djervih in Tjurup, Mooskaskade, 32°–35°C, 7.v.1929. Prof. Feuerborn, leg slidemounted (Müller-Liebenau) in euparal(?).

*Included species.* Nominal species of *Liebebiella* (previously Oriental *Pseudocloeon*) include *L. orientale* (Müller-Liebenau), 1982b, **New Combination** (type species); *Liebebiella ambigua* (Müller-Liebenau), 1982b, **New Combination**; *L. atoki* (Müller-Liebenau), 1982a, **New Combination**; *L. difficila* (Müller-Liebenau), 1982b, **New Combination**; *L. klapaleki* (Müller-Liebenau), 1982b, **New Combination**; *L. proxima* (Müller-Liebenau), 1984b, **New Combination**; *L. siveci* (Braasch), 1983, **New Combination**; and *L. vera* (Müller-Liebenau), 1982b, **New Combination**.

We give *Pseudocloeon* sp. 1 of Ulmer (1939) [characterized and illustrated also by

Müller-Liebenau (1981) and diagnostically compared with other species by Müller-Liebenau (1982b)] the formal name *Liebebiella deigma*, n. sp. We designate type specimens of *L. deigma* from Ulmer's original material as follows: Holotype; mature larva, FM 7, Tjurup, Musi in Ajer Simpang, 6.v.1929, slidemounted (Müller-Liebenau) in euparal(?), deposited Zoological Institut and Zoologisches Museum, University Hamburg. Paratypes, 4 larvae, same data as holotype, 3 larvae (missing head capsules) in alcohol, 1 male larva with mouthparts, legs, forewing of subimago (extracted from larval wingpads), slidemounted (Müller-Liebenau) in euparal(?), remainder of body in alcohol; male larva, South Sumatra, FM8b, Musi-Gebeit, warm spring Subang Ajam on the Kali Djervih in Tjurup, Mooskaskade, 32°–35°C, 7.v.1929. Prof. Feuerborn, leg slidemounted (Müller-Liebenau) in euparal(?), deposited Zoological Institut and Zoological Museum, University Hamburg.

*Distribution.* Oriental.

*Etymology.* Feminine gender. *Liebebiella*—an arbitrary combination of letters based upon the surname of Ingrid Müller-Liebenau, the German ephemeropterist.

*Remarks.* The genus *Liebebiella* is distinguished from all other *Baetis* complex genera by the form of its labium (similar to *Acentrella*) along with the combined presence of dorsal femoral bristles that are multilaterally ciliate (the ciliae are relatively long and dense), a greatly elongated distal bristle on the tarsus, and two well-defined rows of metatibial bristles (one row only in the species *L. atoki*).

As previously alluded to by Müller-Liebenau (1981, 1982b), the group of species that we have placed in the genus *Liebebiella* is clearly derived from an *Acentrella*-like ancestor possessing all of the apomorphies discussed herein under that genus. In addition, *Liebebiella* possesses a distinctive set of autapomorphic characters, including the presence of multilaterally ciliate (ciliae relatively long and dense) dorsal femoral bristles, two rows of long multilaterally ciliate metatibial bristles (except in *L. atoki*), a long distal tibial bristle, and a distinctive medial row of long hyaline bristles on the abdominal terga [independently derived in other unrelated taxa, e.g., *Baetodes* Needham and Murphy (Cohen and Allen, 1978)].

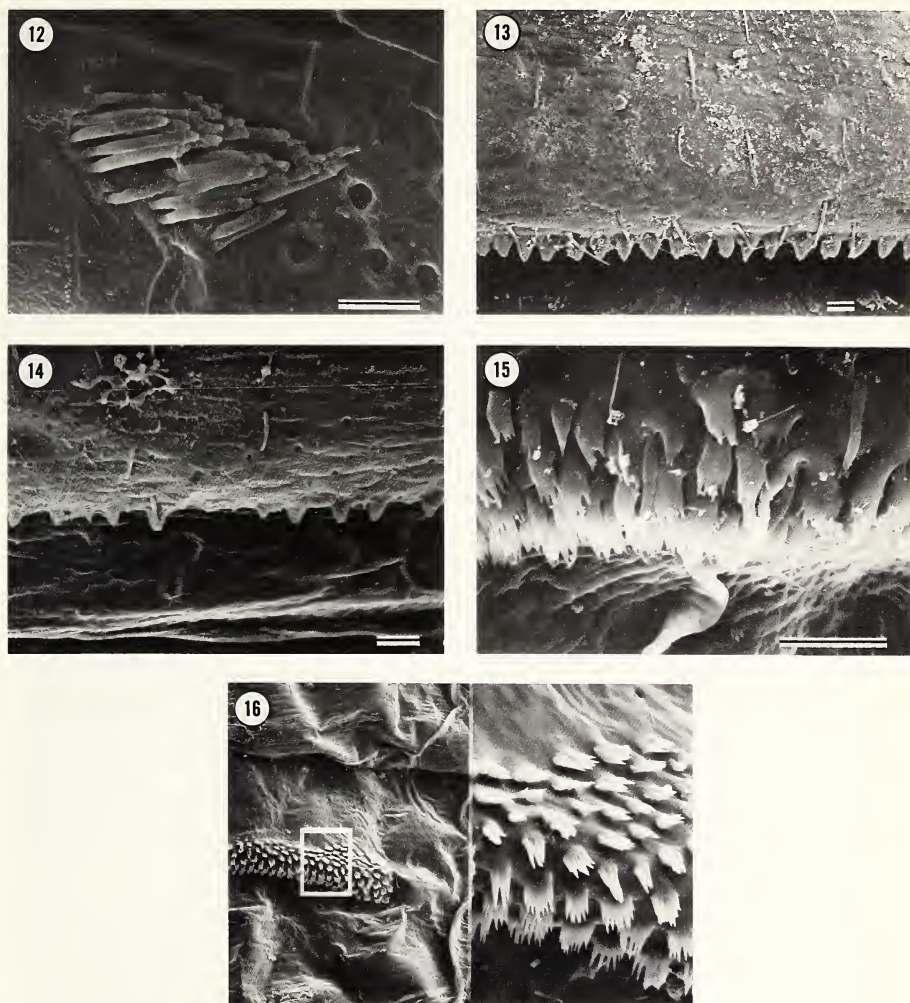
#### *Acentrella* Bengtsson, 1912

*Acentrella* frequently has been placed in synonymy with the genus *Baetis* (e.g., Edmunds and Traver, 1954; Grandi, 1956, 1960; Müller-Liebenau, 1965, 1970; Edmunds et al., 1976; Morihara and McCafferty, 1979a), or regarded as a subgenus of *Baetis* (e.g., Demoulin, 1970). Most recently it has been recognized as a distinct genus closely allied to Oriental species provisionally assigned to *Pseudocloeon* (Müller-Liebenau, 1981, 1982b).

*Description.* Larva. Antennae ca.  $1.5 \times$  length of head capsule and situated in lower one-third of head capsule (Edmunds et al., 1976: fig. 11). Mandibular incisors completely fused or partially fused (i.e., discernible one from another). Maxillary palp two segmented (Müller-Liebenau, 1970: fig. 46c). Labium (Fig. 2) compact with labial palps (Morihara and McCafferty, 1979a: fig. 13b; Müller-Liebenau, 1970: fig. 46d) reduced; segment 2 of labial palps with weakly developed inner lobe; segment 3 of labial palps evenly rounded to slightly truncate.

Thorax broad and dorsoventrally flattened. Prothorax generally with distinctive *lapponica*-type pattern (Müller-Liebenau, 1970: figs. 43, 44). Femora (*ibid.*: figs. 46e,





Figs. 12–16. *Acentrella* spp. larvae. 12. *A. gnom*, ventral femoral patch. 13. *A. ampla*, tergal posterior margin. 14. *A. gnom*, tergal posterior margin. 15. *A. turbida*, tergal posterior margin. 16. *A. turbida*, sternal friction pad. (Scale: Figs. 12–16—bar = 10  $\mu$ m; Fig. 14—no bar)

49e) of all legs with long setae minutely, multilaterally ciliate (the ciliae are relatively short and sparse) or with short glabrate bristles dorsally (*ibid.*: fig. 46e); ventral femoral patch present (Figs. 1, 12). Metatibia with one row of bristles dorsally. Tarsus of all legs without long, ventral subapical seta. Claws with one row of denticles.

Abdomen without dorsal tubercles; often dorsoventrally flattened. Tergal scales and scale bases absent (Figs. 13, 14); median row of long hyaline bristles present or absent dorsally; tube scales present (as in Fig. 8) or absent. Posterior marginal spines (Figs. 13–15) poorly developed, often spiculate or multidentate. Gills simple and



without serrate margins. Cerci with lateral bristles. Median terminal filament generally reduced.

Adult. Forewings with paired marginal intercalaries; crossveins and adjoining membranes unpigmented. Hindwings present or reduced and without costal process, or hindwings absent. Metascutellum flattened and directed posterad (Edmunds et al., 1976: fig. 261). Male genitalia often with strongly sclerotized and rectangulate process (Müller-Liebenau, 1970: fig. 42a, b; Traver, 1935: fig. 168) present between forceps bases.

*Type species. Acentrella lapponica* Bengtsson 1912:110, by original designation.

*Material examined.* *Acentrella lapponica* Bengtsson: 1 larva, Lappland, Sitojoure ö skemmia, örre bjöskrogious, 10.vii.1960, Lok. m. 18, leg. Brink (ZSM); 1 larva, Lappland; 1 larva, Alaska, South Slope, Yukon River System, 29.vii.1972 (USNM); 1 larva, Canada, Northwest Territories, Lake Harbour, Baffin Island, 5.vii.1935 (PERC); 1 larva, Alaska, Atigua River, 1971 (PERC). *Acentrella sinaica* Bogoescu, 1 larva, Portugal, 1971, leg. Puthz (ZSM). *Pseudocloeon gnom* Kluge, 5 larvae, Japan, Yoshino River, Kamiichi Bridge, 18.viii.1984, N. Kobayashi (PERC). *Pseudocloeon turbidum* McDunnough (tentative larval association—RDW), 12 larvae, Oregon, Lane County, Wildcat Creek, 16.v.1982, leg. G.W. Courtney (OrSU). Numerous collections of Nearctic *Baetis amplus* (Traver), *Baetis insignificans* McDunnough, and *Pseudocloeon carolina* (Banks) (BK, CU, PERC, SWRC, USNM, UU, VPI).

*Included species.* Nominal species that we can presently assign to *Acentrella* are *A. lapponica* Bengtsson, 1912 (type species); *A. ampla* Traver, 1932; *A. carolina* (Banks), 1924, **New Combination** (previously Nearctic *Pseudocloeon*); *A. chantauensis* (Kluge), 1981, **New Combination** (previously Palearctic *Baetis*); *A. fenestrata* (Kazlauskas), 1963 **New Combination** (previously Palearctic *Pseudocloeon*); *A. gnom* (Kluge), 1983, **New Combination** (previously Palearctic and Oriental *Pseudocloeon*) [= *Pseudocloeon ultimum* Müller-Liebenau, 1985, **New Synonymy**]; *A. insignificans* (McDunnough), 1926, **New Combination** (previously Nearctic *Baetis*); *A. lata* (Müller-Liebenau), 1985, **New Combination** (previously Palearctic *Pseudocloeon*); *A. sibirica* (Kazlauskas), 1963, **New Combination** (previously Palearctic *Pseudocloeon*); *A. sinaica* Bogoescu, 1931; *A. tonneri* (Braasch and Soldán), 1983, **New Combination** (previously Palearctic *Baetiella*) and *A. turbida* (McDunnough) 1924, **New Combination** (previously Nearctic *Pseudocloeon*). We regard *Acentrella suzukiella* Matsu-mura (1931) as provisionally assignable to *Acentrella* on the basis of published descriptions. The Afrotropical species *A. capensis* Barnard (1932), *A. monticola* Crass (1947), *A. natalensis* Crass (1947), and *A. sp.* A Kimmins (1955) are not congeneric with *Acentrella* but cannot be formally reclassified until a comprehensive review of these species is possible.

*Distribution.* Holarctic and Oriental.

*Remarks.* As redefined herein larvae of the genus *Acentrella* Bengtsson may be separated from all other *Baetis* complex genera by the following combined characters: compact labium with reduced and apically rounded to truncate labial palps; femora, and often the tibia, with relatively long (compared to other *Baetis* species) dorsal bristles; only one row of metatibial bristles; absence of a long distal tibial bristle; absence of tergal scales; poorly developed posterior marginal spines of the abdominal terga; and cerci with prominent lateral setae.

*Acentrella* includes species with hindwings, species with reduced hindwings, and

species without hindwings. The previous diagnoses (Müller-Liebenau, 1981, 1985) of this genus, which were based on reduced size and sexually dimorphic character states of the adult hindwing, are untenable on the basis of larval characters described herein.

Based on outgroup (Holarctic *Baetis*) comparisons, the genus *Acentrella* appears to have been derived from a *Baetis*-like ancestor that as larvae possessed short, glabrous dorsal femoral and tibial bristles, well-developed hindwing pads, scaled abdominal terga, well-developed posterior marginal spines, spinous margined gills, and a median terminal filament subequal to the cerci. From this a derived lineage constituting *Acentrella* demonstrates the following apomorphies in its most ancestral species: 1) compaction of the mouthparts including a reduction in the relative lengths of the labial palp segments, 2) reduction of the hindwing pads, 3) loss of abdominal tergal scales, 4) reduction of the posterior marginal spines, 5) loss of marginal spines on the gills, and 6) reduction in the size of the median terminal filament relative to the cerci.

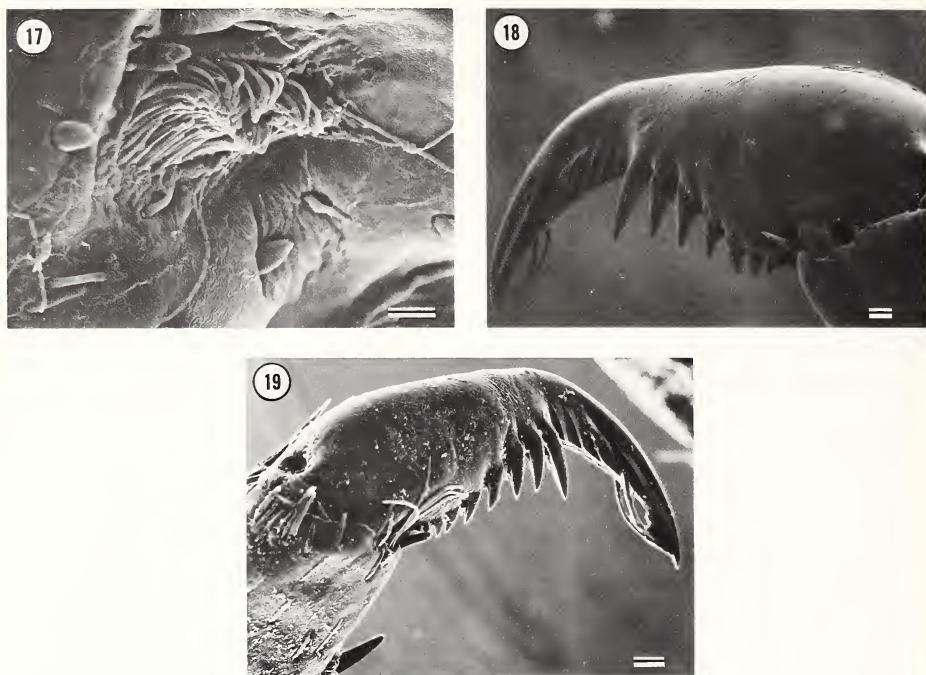
Genera closely allied to *Acentrella* include *Heterocloeon* McDunnough (Moriwara and McCafferty, 1979c) and *Liebiella*. Species previously associated with *Pseudocloeon* that were found to be closely allied to *Heterocloeon* by Moriwara and McCafferty (1979c) belong to *Acentrella*.

Within *Acentrella* several apomorphic larval characters appear that may be indicative of phylogenetically related subgroups of species within the genus. One such character is the presence of spiculate or multidentate posterior marginal spines (Fig. 15) of the abdominal terga. Although all species of *Acentrella* possess reduced posterior marginal spines, some species, e.g., *A. lapponica*, *A. carolina*, *A. chantauensis*, *A. fenestrata*, *A. sibirica*, *A. sinaica*, and *A. turbida*, possess posterior marginal spines that are very reduced and that form distinct spiculae, some or all of which may be multidentate depending on the species considered. The relatively more ancestral posterior marginal spines found in the remaining species of *Acentrella* retain the appearance of a single row of distinctly formed spines that are not spiculate (Fig. 13). The subgroup including *A. lapponica* also shows a tendency for a dorsoventral flattening of the abdomen and a correlated increase in the size of the paired abdominal friction pads (Fig. 16) that individually may extend to cover about one-third of each abdominal sternite, and a tendency for dark-colored abdominal terga 2–6 in the adult stage rather than light colored terga as may be found in other species.

In the majority of *Acentrella* species we examined, the clypeus and labrum are distinctly folded beneath the head capsule as described and illustrated by Edmunds et al. (1976: fig. 111), although at least one of the relatively more enigmatic species, *A. ampla*, does not possess this character. We have seen baetids including members of the Nearctic *Baetis propinquus* species group (Moriwara and McCafferty, 1979b) and other species, which are clearly unrelated to *Acentrella* and its cognates, that have independently derived a similar positioning of the clypeus and labrum beneath the head capsule.

#### *Baetiella* Ueno, 1931

*Neobaetiella* Müller-Liebenau, 1985:103, **New Synonymy**. [Type species. *Neobaetiella uenoi* Müller-Liebenau, 1985:108, by original designation.]



Figs. 17–19. *Baetiella* spp. larvae. 17. *B. japonica*, ventral femoral patch. 18. *B. japonica*, claw. 19. *B. bispinosa*, claw. (Scale: Figs. 17–19—bar = 10  $\mu$ m)

The genus *Baetiella* Ueno has been variously regarded as a subgenus of *Pseudocloeon* Klapálek (Kazlauskas, 1963) or a synonym of *Pseudocloeon* (Bogoescu and Tabacaru, 1957; Gose, 1980; Müller-Liebenau, 1985). We regard *Baetiella* as a distinct and valid genus.

**Description.** Larva. Antennae ca.  $1.5 \times$  length of head capsule. Mandibular incisors (Müller-Liebenau, 1985: fig. 6e) discernible one from another, i.e., with visible fusion line. Maxillary palp two segmented (*ibid.*: fig. 6d). Labium (Fig. 3; *ibid.*: fig. 6b) with palps shortened; segment 2 of palp with weakly developed inner lobe; segment 3 of palp distinctly coniform and symmetric.

Prothorax without distinctive *lapponica*-type color pattern. Femora of all legs with long, non-ciliate bristles (*ibid.*: fig. 6m); ventral femoral patch present (Figs. 1, 17). Metatibia with one row of long dorsal bristles. Tarsus of all legs without long ventral subapical bristle. Claws (Figs. 18, 19) with one row of denticles.

Abdomen with single or paired dorsal tubercles (Fig. 20; *ibid.*: fig. 13; Gose, 1980: fig. 53) or without dorsal tubercles and not dorsoventrally flattened. Scales present or absent, median row of long, hyaline bristles absent dorsally; tube scales sometimes present. Posterior marginal spines (Fig. 21) numerous, distinct, and entire. Gills simple and without serrate margins. Cerci with numerous bristles or with numerically reduced lateral bristles (Figs. 22, 23) on interior margin. Median terminal filament shorter than cerci.

Adult. Forewings (Gose 1965: fig. 1) with paired marginal intercalaries and often



with distinctly pigmented areas adjoining and including the crossveins. Metascutellum (Edmunds et al., 1976: fig. 262) not flattened but projecting dorsoposteriorly. Male genitalia without medial process (Gose, 1965: fig. 4).

*Type species. Acentrella japonica* Imanishi, 1930:110, by original designation (Ueno, 1931).

*Material examined. Baetiella japonica* (Imanishi), 2 male imagos, Japan, Sagami River, Ogra Bridge, 29.xi.1984, leg. N. Kobayashi (PERC); 5 larvae, Japan, Kawazu River, Kawazu Bridge, 4.iii.1985, leg. N. Kobayashi (PERC); 30 larvae, Korea, Taeha, Ullung, Kyongsanbuk-do, 3.viii.1983, leg. Y. J. Bae (PERC); 5 larvae, Korea, Taebaeksan, Taebaek, Kangwon-do, 13.viii.1983, leg. Y. J. Bae (PERC). *Pseudocloeon bispinosa* Gose, 15 larvae; Taiwan; Tahan River near Wu-Liao (about 23 km SW Taipei), 9.x.1978, G. F. and C. H. Edmunds (UU). *Baetiella ladakae* Traver, paratype male imago, forewing (slidemounted) and male genitalia (slidemounted) (UU). *Pseudocloeon tuberculatum* Kazlauskas, 6 larvae, Korea, Chojongchon, Kapyong, Kyonggi-do, 26.iv.1973, leg. I. B. Yoon (PERC). *Baetiella* sp. male imago, Rokki, Formosa (Taiwan), 13.vi.1932, leg. J. L. Gressitt (MCZ). *Baetiella* sp., Traver, 1939, 1 larva, Kashmir, Kangan, Sind River, collection K-57, 16.v.1932, alt. 5,795 ft. (UU).

*Included species. Baetiella japonica* (Imanishi), 1930 (type species); *Baetiella aino* (Matsumura), 1931, **New Combination** (previously Palearctic *Pseudocloeon*); *B. armata* Braasch; *B. ausobskyi* Braasch; *B. bispinosa* (Gose), 1980, **New Combination** (previously Palearctic *Pseudocloeon*) [= *Neobaetiella macani* Müller-Liebenau, 1985:108, **New Synonymy**] [= *Neobaetiella imanishi* Müller-Liebenau, 1985:108, fig. 19, **Nomen Nudum** (an editorial oversight)]; *B. imanishii* Braasch; *B. innotata* (Braasch), 1978, **New Combination** (previously Palearctic *Baetis*); *B. ladakae* Traver, 1939; *B. marginata* Braasch; *B. muchei* (Braasch), 1978, **New Combination** (previously Palearctic *Pseudocloeon*); *B. tuberculata* (Kazlauskas), 1963, **New Combination** (previously Palearctic *Pseudocloeon*) [= *Neobaetiella uenoi* Müller-Liebenau (1985:107), unavailable name, Articles 1b(6) and 13b ICZN]; and *B. ursina* (Kazlauskas), 1963, **New Combination** (previously Palearctic *Baetis*).

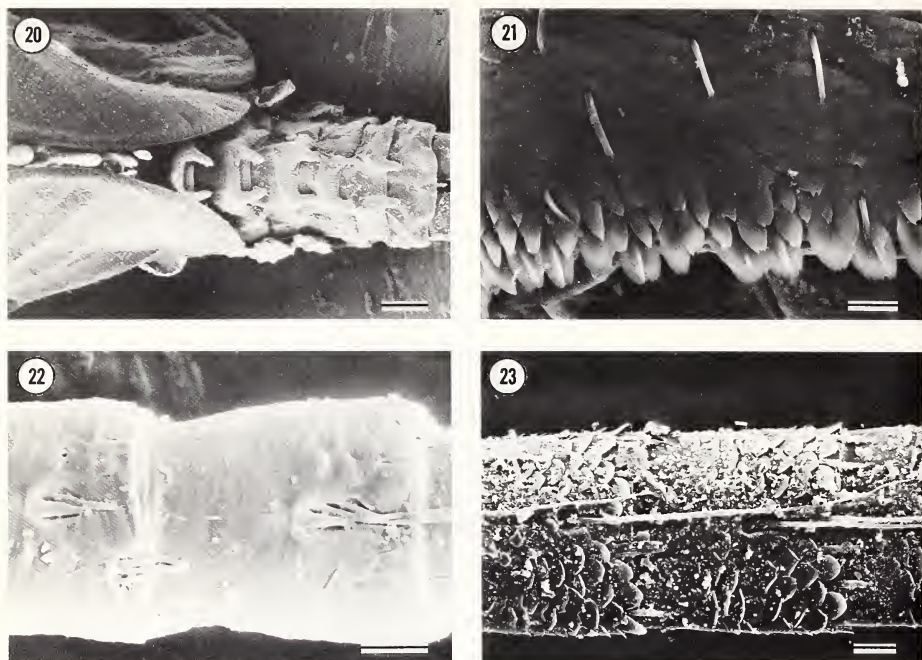
*Distribution.* Palearctic, Oriental.

*Remarks.* Larvae of *Baetiella* are distinct from all other *Baetis* complex genera by the uniquely conical form of the third labial palpal segment; femora with relatively long (compared to other *Baetis* complex species) dorsal bristles; numerous and distinct posterior marginal spines; and an abdomen that is not dorsoventrally flattened.

Although we do not know the general applicability of Kluge's (1983) biological and behavioral observations regarding *B. tuberculata*, we do emphasize two points that may eventually be found to have systematic significance. First, is an observation that the subimago of *B. tuberculata* rests with its wings outstretched. Other baetid subimagos that we know of hold the wings vertically uplifted over the body. The second observation is that the pigmentation of the forewings takes approximately 24–48 hours to develop fully. This latter observation has obvious implications in that preserved specimens of teneral adults (less than 24 hr old) may not possess the characteristic pigmentation of the wings.

*Baetiella* appears to have been derived independently of *Acentrella*. This conclusion is supported by numerous character data. We hypothesize that *Baetiella* was derived from a *Baetis*-like ancestor, but the particular species complex for outgroup comparisons of *Baetiella* is not clear. Müller-Liebenau (1970) suggested that *B. ursina*,





Figs. 20–23. *Baetiella* spp. larvae. 20. *B. bispinosa*, dorsal abdomen. 21. *B. japonica*, tergal posterior margin. 22. *B. tuberculata*, cerci. 23. *B. bispinosa*, cerci. (Scale: Fig. 20—bar = 100  $\mu$ m; Figs. 21–23—bar = 10  $\mu$ m)

which we regard as a relatively plesiomorphic species of *Baetiella*, appeared to be related to the *Baetis niger* group of species. Our own review of this species, based in part on adult data presented by Kluge (1983), indicates a possible relationship with *Baetis lutheri* Müller-Liebenau due to similarities of the male genitalia and striking similarities in the larval mouthpart and tergal structures. The synapomorphies defining *Baetiella*, i.e., the uniquely formed mouthparts, tergal armature, gills, reduced median terminal filament and characters of the cerci, are evidently derived from within the *Baetis* complex of genera and independent of the *Acentrella* lineage.

The relatively most ancestral species of *Baetiella* are the distinctive and possibly synonymous Palearctic *B. ursina* and *B. innotata*. These retain a moderately developed median terminal filament, cerci that bear numerous bristles along the interior margin and that are shorter than the body in length, tergal scales, and a well-developed hindwing pad in the larval stage. In all other known *Baetiella* the median terminal filament of the larval stage is reduced to one segment, the cerci bear numerically reduced bristles along the interior margin and are of variable length but often longer than the body in length, tergal scales are absent, and the hindwing pad is greatly reduced or absent. Kluge (1983) has described the adult of *B. ursina*, which apparently differs from other known *Baetiella* species by the retention of the relatively plesiomorphic condition (determined by outgroup comparisons, i.e., *Baetis*) of forewings

that are clear and unpigmented. Other known adults of *Baetiella* possess clearly pigmented areas adjacent to and including the crossveins of the forewings.

*Baetiella japonica na* Imanishi and *Baetiella japonica* (Imanishi), the type species, are not the same. The type species of *Neobaetiella* was improperly designated by Müller-Liebenau (1985) to be the descriptively proposed and temporary taxon *Baetiella japonica na* Imanishi, 1940, for which she proposed the new name *Neobaetiella uenoi* Müller-Liebenau (1985:107) (erroneously cited as new combination). The designation of a new name for the above taxon does not meet the criteria of name availability [International Code of Zoological Nomenclature, 3rd ed., Article 1, b(6) and Article 13] because the description of *Baetiella japonica na* by Imanishi was clearly intended as a temporary reference [Article 1, b(6)] and not a formally described taxon. Furthermore, Kluge (1983) demonstrated that the proper name to which Imanishi's (1940) larva refers was *Pseudocloeon tuberculatum* Kazlauskas, 1963 (now *Baetiella tuberculata*). In addition, *Baetiella nasegawensis* Gose, 1965, was designated a junior synonym of *P. tuberculatum* by Kluge (1983). Müller-Liebenau (1985) included discussions of *P. tuberculatum* in her review, but did not formally transfer it to *Neobaetiella* (1985:108). In any case, her intended type of *Neobaetiella* is actually synonymous with *B. tuberculata*.

Based on our study of *B. tuberculata*, we found that in all characters (both larval and adult) this species is not generically distinct from other *Baetiella* and is congeneric with *B. japonica* (the type species of *Baetiella*). *Baetiella tuberculata*, *B. ausobskyi*, *B. armata*, and *B. imanishii* are uniquely characterized among all other described *Baetiella* by the presence of a dorsal tubercle on the posterior margin of the abdominal terga. *Baetiella bispinosa* [the only other nominal species originally placed in *Neobaetiella* as *N. macani* by Müller-Liebenau (1985)] possesses bilobed tubercles on the posteriormost abdominal terga and a single tubercle on segments 1–3. The presence and condition, or absence, of tubercles is intragenerically variable in at least some other baetid genera, e.g., *Jubabaetis* (unpublished) and the New World genus *Baetodes* (Cohen and Allen, 1978). Further, the distinctive and highly derived *B. bispinosa* possesses all of the synapomorphic characters that we regard as diagnostic for larvae of the genus *Baetiella*.

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## NEOTROPICAL NABIDAE (HETEROPTERA), 2: A NEW SPECIES OF METATROPIPHORUS

I. M. KERZHNER

Zoological Institute, Academy of Sciences of the USSR,  
Leningrad, USSR 199034

*Abstract.*—A new species *Metatropiphorus alvarengai* (Surinam, Brazil, Argentina) is described.

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The present paper is based on materials of the American Museum of Natural History, New York (AMNH) and the National Museum of Natural History, Washington, D.C. (USNM) kindly sent to me for study by R. T. Schuh and T. J. Henry correspondingly. Some paratypes originating from the AMNH collection are retained in Zoological Institute, Leningrad.

### ***Metatropiphorus alvarengai*, new species**

Figs. 1–6

*Description.* Apex of head, rostrum, antennae, legs, and medial part of mesothoracic sternum strongly shining, remaining parts dull or feebly shining. Dorsal side of head, fore lobe of pronotum, scutellum, and femora covered by long nearly upright light hairs, the hairs on hemelytra shorter. Hind lobe of pronotum, and coriaceous part of hemelytra with small and shallow wrinkles and pits, without distinct punctures.

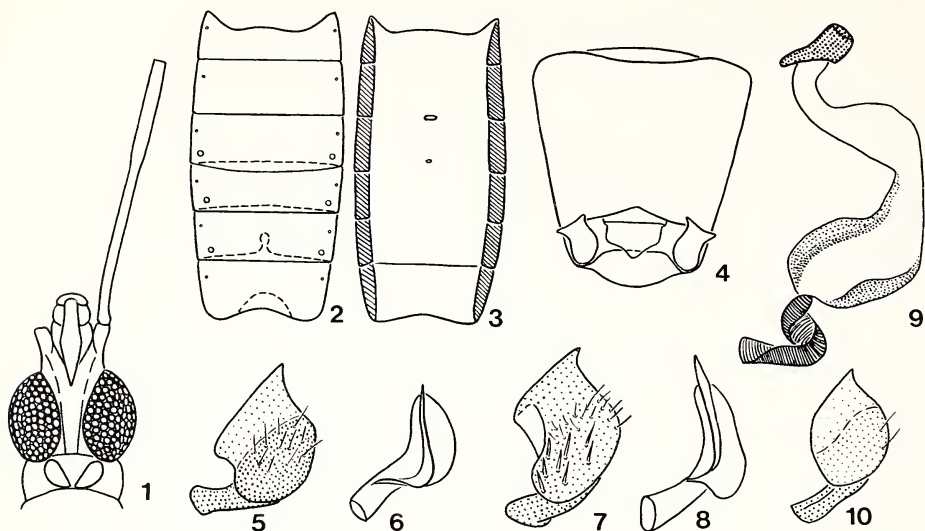
Head 1.5 times longer than wide, black, sometimes brownish yellow at apex. Eyes large, with large facets, the width of vertex between eyes equals  $\frac{2}{5}$  to  $\frac{1}{2}$  of eye width and about  $\frac{1}{4}$  to  $\frac{1}{3}$  of eye length. Ocelli large, divided by a dull triangular spot subequal in width to one ocellus. Rostrum brown, scarcely surpassing the fore coxae. Antennae dark brown to black, segment I twice as long as head, II 1.4–1.5 times longer than I.

Pronotum reddish brown, fore lobe partly or completely black, hind lobe without medial shining stripe. The length of pronotum slightly more than its width in male, as a rule slightly less than its width in female. Scutellum dark brown or nearly black. Hemelytra strongly surpassing the apex of abdomen, blackish brown, with clavus behind the scutellum, apex, outer margin, and inner discal cell of corium mostly more light colored, dirty brownish yellow.

Coxae and trochanters mostly black or dark brown. Femora dark brown to nearly black, basal  $\frac{2}{3}$  of middle femora, and basal  $\frac{3}{4}$  to  $\frac{2}{3}$  of hind femora dark yellow, in specimens from Santa Catarina and Argentina also with dark yellow stripes at fore and hind margins on basal  $\frac{1}{2}$  to  $\frac{2}{3}$  of fore femora. Fore femora 6–7 times longer than wide. Tibiae yellow with brown or black apex, sometimes completely brown. Tarsi black.

Abdomen dark brown to black, sometimes basal sternites with a longitudinal yellowish stripe, tergites I–VII (except laterotergites) membranous, whitish.

Parameres with the hairy part very convex, marginal plate yellowish, with projecting corners.



Figs. 1-10. 1-6. *Metatropiphorus alvarengai*. 1. Head and antennal segment I, dorsal. 2. Segments II-VII of abdomen of a female, ventral. 3. Segments I-VII of abdomen of a female, dorsal. 4. Male genital segment, dorsal. 5. Left paramere, lateral. 6. Same, ventral. 7-9. *M. belfragii*. 7. Left paramere, lateral. 8. Same, ventral. 9. Aedeagus. 10. *M. drakei*, left paramere, lateral.

Measurements (based on 5♂♂ and 5♀♀ from Mato Grosso Prov.): head width 0.59-0.64, vertex width 0.10-0.13, pronotum length 1.19-1.31, its width in male 1.14-1.20, in female 1.21-1.33, length of antennal segments I-IV 1.21-1.36, 1.67-1.93, 1.29-1.36, 0.76-0.83 mm.

In specimens from Surinam and Mato Grosso total length of male 6.3-6.6, female 6.8-7.1, width of male 1.1-1.2, female 1.2-1.4 mm. Specimens from Bahia, Santa Catarina and Argentina are larger (length of male 7.7-8.0, female 8.4-8.7, width of male 1.3-1.4, female 1.6 mm) and with larger parameres, but not differing in form and proportions.

*Holotype*. ♂ BRAZIL. *Mato Grosso*: Vila Vera, 55°30'W, 12°46'S, Oct. 1973, M. Alvarenga (AMNH).

*Paratypes*. SURINAM. *Moengo*: Boven Cottica R., 16 May 1927, Cornell Univ. Lot 760, Sub. 60, "*Metatropiphorus* n. sp. Harris det.," H. M. Harris Coll. (USNM), ♀ without head. BRAZIL. *Mato Grosso*: same data as for holotype (AMNH), 8♂♂, 7♀♀; *Sinop*: 55°37'W, 12°31'S, Oct. 1974, M. Alvarenga (AMNH), 3♂♂, 2♀♀. *Bahia*: Encruzilhada, 960 m, Nov. 1972, M. Alvarenga (AMNH), ♂, ♀. *Santa Catarina*: Nova Teutonia, 3 Sept. 1943, F. Plaumann (USNM), ♀. ARGENTINA. *Buenos Aires*: Tigre, Jan. 1956, J. Daguerre (USNM), ♂, ♀; San Fernando, Jan. 1958, J. Daguerre (USNM), ♂.

*Etymology*. Named in honor of Brazilian entomologist M. Alvarenga, who collected the holotype and most of the paratypes.

*Discussion*. Three species of *Metatropiphorus* were known before this study: *M. drakei* Harris (West Indies), *M. belfragii* Reuter (U.S.A., all records from the West

Indies belong to the former species), and the extinct *M. succini* (Jordan) from Baltic amber. Both recent species differ from *M. alvarengai* in more light, predominantly light gray or dirty yellow coloration, besides the ocelli are subcontiguous, head between them shining, hind lobe of pronotum with a shining longitudinal stripe, parameres less convex, their outer corner broadly rounded in *M. drakei* and with a nearly discolored area in *M. belfragii*. In *M. succini* antennal segment I is much longer.

#### ACKNOWLEDGMENTS

I am thankful to R. T. Schuh and T. J. Henry who provided me with material for this study.

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**TWO NEW SPECIES OF *HETEROMURUS* FROM SULAWESI UTARA (CELEBES) AND A NEW RECORD FOR *H. TENUICORNIS* BÖRNER (COLLEMBOLA: ENTOMOBRYIDAE)**

JOSÉ A. MARI MUTT

Department of Biology, University of Puerto Rico, Mayagüez, Puerto Rico 00708

*Abstract.*—*Heteromurus* (*Heteromurtrella*) *greensladeae* and *H. (H.) affinis* are described from material collected in various localities in Sulawesi Utara (Celebes). *Heteromurus* (*Alloscopus*) *tenuicornis* is reported for the first time from Sulawesi.

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Through the kindness of Ms. Penelope Greenslade, Australian National Insect Collection, Canberra City, I have been able to study the complete collection of *Heteromurus* gathered by her and her colleagues during a 1985 visit to Sulawesi Utara (Celebes). The material includes two new species of the holotropical subgenus *Heteromurtrella* and one species of the Oriental subgenus *Alloscopus*.

Unless otherwise stated, all the specimens studied were collected by Ms. Greenslade. Holotypes and most paratypes of the new species are deposited in the Australian National Insect Collection. Some paratypes and several specimens of *Heteromurus tenuicornis* Börner are in my collection.

***Heteromurus* (*Heteromurtrella*) *greensladeae*, new species**

*Description.* Length to 1.8 mm. Light orange pigment dispersed over head and body (Fig. 1) or pigment restricted to eye patch. Apex of fifth antennal segment without a retractile papilla or pin seta but with 1 conspicuous, apically dilated J-shaped seta (Fig. 5). Head macrochaetotaxy as in Figure 10. Eyes 1+1. Prelabral and labral setae smooth. Outer labral papillae domelike, inner papillae conelike (Figs. 3, 4). Setae of anterior labial row smooth; posterior row with 2 ciliated setae, 3 smooth setae and 2 scales (Fig. 9). Basal seta of maxillary palp slightly thicker than apical seta (Fig. 7). Differentiated seta of outer labial papilla short and thick (Fig. 2). Along cephalic groove 2+2 smooth setae (postlabial quadrangle) and near posterior margin of head 2+2 or rarely 3+3 ciliated setae; other setae on venter of head smooth or ciliated. Body macrochaetotaxy as in Figure 11. All tibiotarsal setae ciliated. Unguis with basal pair of winglike teeth and no unpaired teeth (Fig. 6). Unguiculus with large outer tooth. Dorsum of manubrium with many scales, ciliated setae and 4+4 smooth erect setae (Fig. 14); 2 similar smooth setae on base of dentes. Dental spines absent. Mucro (Fig. 8) without basal spine.

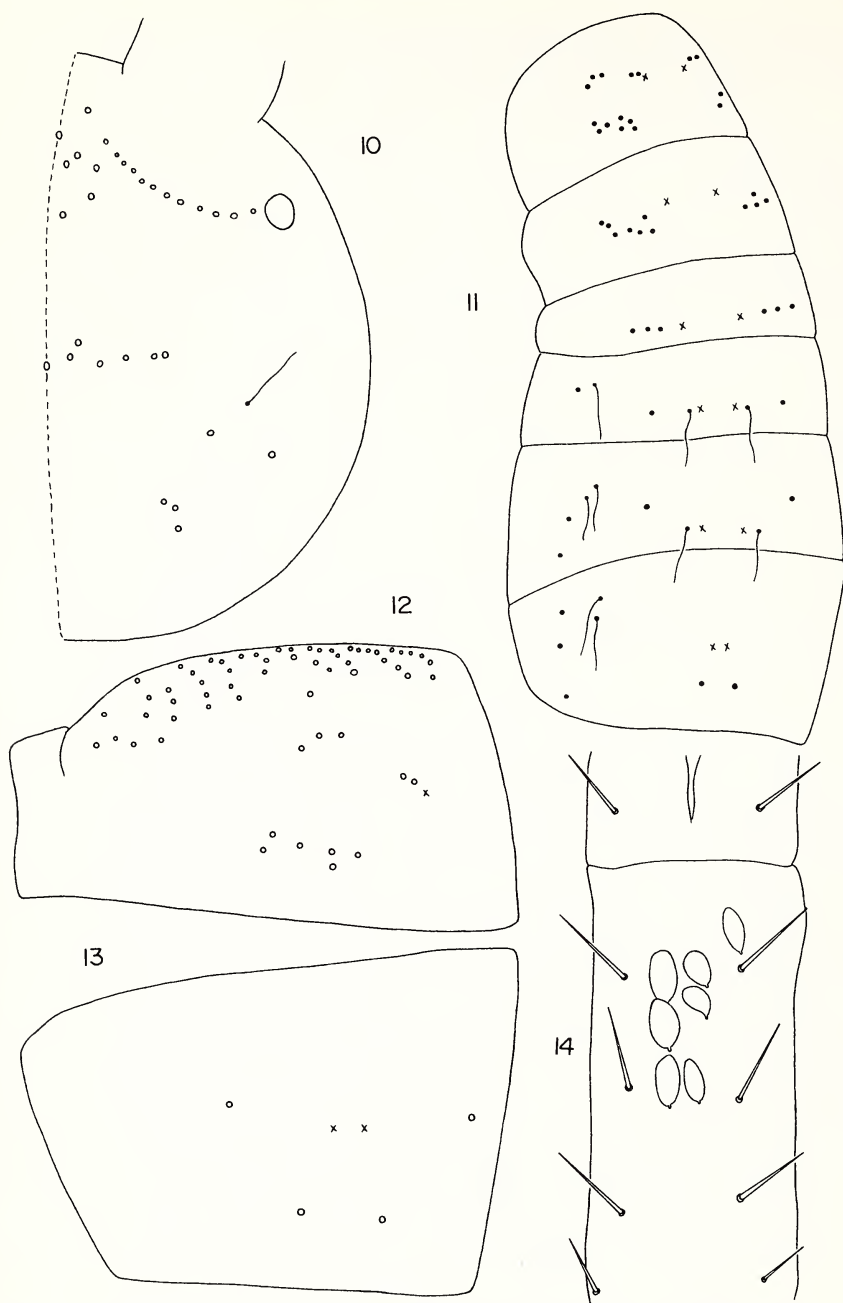
*Diagnosis.* This new species, and the one described below, are the only members

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Figs. 1-9. *Heteromurus* (*Heteromurtrella*) *greensladeae*. 1. Habitus and distribution of light orange pigment. 2. Outer labial papilla. 3-4. Labral papillae; 3. anterior view, 4. ventral view. 5. Apex of fifth antennal segment. 6. Metathoracic claws. 7. Maxillary palp. 8. Mucro. 9. Labial chaetotaxy.





Figs. 10–14. Figs. 10, 11, 14. *Heteromurus (Heteromurtrella) greensladeae*. Figs. 12, 13. *H. (H.) affinis*. 10. Head macrochaetotaxy. 11. Body macrochaetotaxy (setae on anterior margin of Th. 2 omitted) and distribution of pseudopores (x). 12. Macrochaetotaxy of second thoracic segment. 13. Macrochaetotaxy of fourth abdominal segment. 14. Distribution of smooth setae and some scales on dorsum of manubrium.

of the subgenus *Heteromurtrella* with labial scales. *Heteromurus greensladeae* is similar to *H. nitens* Yosii 1960, a species described from the Tonga Islands and whose labial chaetotaxy is unknown. The unguis of *H. nitens* has an unpaired inner tooth that is absent in specimens of *H. greensladeae*.

*Material examined.* Sulawesi Utara (Celebes), Dumoga-Bone National Park, '1440' camp, 211 m, 2–7.x.1985, pitfall traps, leaf litter and moss. Holotype and 5 paratypes on slides, 29 paratypes in alcohol. Dumoga-Bone National Park, Mogonanipa summit, 1,008 m, 22–24.ix.1985, pitfall traps, leaf litter and moss, 9 paratypes on slides and 34 in alcohol.

### ***Heteromurus (Heteromurtrella) affinis*, new species**

This species is identical to *H. greensladeae* except for two details of the body chaetotaxy. The second thoracic segment of *H. affinis* lacks the innermost posterior macrochaeta present in *H. greensladeae* (cf. Figs. 11, 12) while the fourth abdominal segment has an extra macrochaeta that is absent in *H. greensladeae* (cf. Figs. 11, 13). These differences may be minor and could simply reflect geographic variation but until both setal patterns are found within a population or intermediate forms appear I prefer to regard both forms as separate species.

*Material examined.* Sulawesi Utara (Celebes), G. Muajat, 1,760 m, 16.ix.1985, H. Huitbregts col., holotype and 4 paratypes on slides, 2 paratypes in alcohol. G. Muajat, below summit, 1,780 m, 1985, Hornabrook, col., 1 paratype on slide. Danau Mooat, nr. Kotamobagu, 1,200 m, viii.1985, Hornabrook, col., 1 paratype on slide. As preceding but collected 11.ix.1985 by P. Greenslade, 1 paratype on slide.

### *Heteromurus (Alloscopus) tenuicornis* Börner

This species was previously known from Indonesia (Java and Sumatra), the Philippine Islands (Luzon), Micronesia and Hawaii. In the Philippine Islands the species exists in two forms (Mari Mutt, 1985). The Sulawesi specimens belong to the form with labial setae M1 and e smooth, and all setae on the venter of the head also smooth. Specimens of this Philippine form also possess 4+4 smooth setae on the manubrium. In some Sulawesi specimens there seem to be only 2+2 smooth manubrial setae but other individuals possess at least 3+3 setae.

*Material examined.* Sulawesi Utara (Celebes), Dumoga-Bone National Park, 200–300 m, 27.ix–7.x.1985, pitfall traps, 2 specimens on slides and 4 in alcohol. Hogs Back, 492 m, litter, 24.ix.1985, 2 specimens on slides and 6 in alcohol. As preceding but at 400–500 m, 14.x.1985, 1 specimen on slide. The Maze, second stream, under stones, 9–10.x.1985, 2 specimens on slides.

### ACKNOWLEDGMENT

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